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Stock Price Dynamics in Response to Petroleum Discoveries: A Case Study of Galp’s discovery in Namibia

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Master's Degree in Monetary and Financial Economics,

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ISCTE-IUL

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"It takes considerable knowledge just to realize the extent of your own ignorance."

~Thomas Sowell

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The end of this project is the outcome of struggles that began long before I was born. I could not miss the opportunity to express my gratitude to the people that have always supported me.

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Resumo

Este estudo investiga a reação do mercado de capitais ao anúncio da Galp Energia sobre a descoberta de petróleo na Namíbia, em 21 de abril de 2024. A descoberta, que pode mais do que triplicar as reservas da empresa, representa um evento de grande relevância. Utilizando a Hipótese do Mercado Eficiente como base teórica, esta análise procura verificar se o mercado ajusta-se de forma eficiente a esta informação.

Através da metodologia de estudo de eventos, a análise dos retornos anormais da Galp confirmou um ajuste de mercado rápido e substancial. A ação teve retornos anormais positivos no dia do anúncio, entre +15,1% e +18,4%, com alta significância estatística. Este aumento representou a maior parte da revalorização total da empresa nas janelas de evento estudadas. A ausência de retornos anormais positivos antes do anúncio sugere que não houve fugas de informação. Além disso, os retornos anormais cumulativos mostram que os ganhos foram duradouros, sem sinais de reversão, o que indica que o mercado não reagiu de forma excessiva.

Em resumo, os resultados apoiam a existência de um mercado eficiente na forma semiforte, que incorpora rapidamente a nova informação pública. As conclusões reforçam a importância da comunicação atempada das empresas e do papel dos reguladores na manutenção da integridade do mercado, demonstrando também que o potencial de lucro para investidores a partir de anúncios públicos é limitado, devido à imediata reação dos preços.

Palavras-chave: Estudo de Evento; Retornos Anormais; Retornos Anormais Cumulativos; Hipótese de Mercado Eficiente; Descobertas de Petróleo; Galp Energia.

Classificação JEL: G14, C58.

Abstract

This study investigates the capital market's reaction to the announcement of an oil discovery by Galp Energia in the Orange Basin, Namibia, on April 21, 2024. This discovery represents a significant event. It has the capacity to more than triple the company's oil reserves. Using the Efficient Market Hypothesis as the theoretical foundation, this dissertation tries to test if the market adapts efficiently to such important information.

By using the event study approach, the analysis of Galp's abnormal returns through various models confirmed a very rapid and large market adjustment. The stock had positive abnormal returns on the event day ranging from +15.1% to +18.4% and showed high statistical significance. This rapid increase accounted for the majority of the total revaluation. The absence of pre-announcement positive abnormal returns shows no significant evidence of widespread information leakage, and the analysis of the cumulative abnormal returns shows the gains to be long lasting and not having any reversal signs within the event windows studied, implying that the market did not overreact.

Overall, the findings offer strong support for the presence of a semi-strong efficient market that rapidly and accurately incorporates newly released public information. The consequences reinforce the importance of timely company communication, highlight the role of regulators in maintaining market integrity by discouraging insider trading activities, and demonstrate that the investors' potential for profit from public announcements is extremely limited since prices respond with little notice effect.

Keywords: Event Study; Abnormal Returns; Cumulative Abnormal Returns; Efficient Market Hypothesis; Oil Discoveries; Galp Energia

JEL Classification System: G14, C58.

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Glossary of Acronyms

ADF: Augmented Dickey-Fuller

AAR: Average Abnormal Return

AMH: Adaptive Market Hypothesis

AR: Abnormal Return

BHAR: Buy-and-Hold Abnormal Returns

CAAR: Cumulative Average Abnormal Returns

CAR: Cumulative Abnormal Returns

EGARCH: Exponential Generalized Autoregressive Conditional Heteroskedasticity

EMH: Efficient Market Hypothesis

EUR: European Monetary Currency

GARCH: Generalized Autoregressive Conditional Heteroskedasticity

i.i.d.: Independent and Identically Distributed

MLE: Maximum Likelihood Estimation

MM: Market Model

NAs: Missing Values

OLS: Ordinary Least Squares

P/E: Price-to-Earnings

PEL: Petroleum Exploration License

PSI: Portuguese Stock Index

RWH: Random Walk Hypothesis

SVAR: Structural Vector Autoregression

Introduction

On 21 April 2024, Galp Energia announced the successful flow test results of its Mopane-1X well in offshore Namibia. This was a milestone in company history. The well, drilled in the Orange Basin within Petroleum Exploration License (PEL) 83, confirmed that there is a significant light oil column with excellent reservoir characteristics. The flow test not only proved the economic potential of the reservoir but also suggested that it is one of the most significant offshore discoveries in recent times (Galp, 2024).

This release represented the culmination of more than ten years of exploration activity in Namibian waters. Galp entered the area on a farm-in deal with HRT Participações in 2012 and subsequently acquired full rights on PEL 83 in 2016 (Galp, 2019). While previous drilling campaigns did not result in commercially viable discoveries (Galp, 2013a, 2013b, 2013c), they confirmed the geological presence of oil systems. These early results formed the basis of what was to be a strategic asset for Galp and a potential game-changer for Namibia's emerging energy sector.

The importance of the discovery announced in April 2024 resonated in the financial markets. Galp's share price witnessed an unprecedented boost, touching new all-time highs and adding approximately $2.5 billion to its market capitalization within just one day. To put that into context, Galp had 620 million barrels of oil reserves in 2023. The new confirmed discovery suggests the company could now have more than two billion recoverable barrels in Namibia alone, a more than tripling of its reserve base (Financial Times, 2024). In-house estimates suggest more than ten billion barrels of oil equivalent in place in the Mopane complex. Even after accounting for geological risk, extraction cost, and natural dilution, energy consultancy firm Wood Mackenzie, according to Financial Times (2024), estimates the value of the discovery at more than $9 billion based on Galp's 80% share and a constant price of $65 per barrel of oil.

This find radically alters Galp's strategic standing. The firm had been regarded as a regional mid-player with Brazilian core interests and natural gas interests in Mozambique and São Tomé. Galp is now regarded as possessing one of the world's most exciting newly discovered oil reserves.

Apart from its financial significance, this find is part of a broader industry trend: frontier oil exploration is ongoing, and possibly lucrative, despite growing pressure on fossil fuels from climate-driven regulatory shifts. As the Financial Times (2024) indicates, Galp's success has attracted the attention of larger competitors in the sector such as Shell, TotalEnergies, and Chevron, most of whom are already established in the Orange Basin and may look to purchase a stake in the project.

The massive market response gives us a fascinating puzzle in financial economics: did the market price it right? The spontaneous €2.5 billion revaluation in Galp is an indicator test of one of the most basic and controversial ideas in finance: the Efficient Market Hypothesis (EMH). As presented by Fama (1970), the semi-strong form of the EMH asserts that share prices fully and immediately reflect all publicly available information. If that claim was true, then the massive increase in Galp's share price within a day or two would be a quick, accurate, and unbiased assessment of the discovery's net present value. But if the reaction were slow, muted, or later corrected, it would lend support to the EMH's critics, and be in line with the behavioral finance theories put forward by researchers like Shiller (2015), which emphasize investor psychology and market imperfections.

The basic tool in analyzing such a phenomenon is the event study method, a tool that has been developed by researchers like Brown and Warner (1985) and has gained a central role in empirical finance. By subtracting the abnormal return (AR), the part of the return that is solely attributed to the announcement, we are able to test the efficiency of the market and the economic consequences of the news. Even if the theoretical foundation is well laid out, its application in a certain, big-stakes event like Galp's find still retains important value. The shift transfers the discussion from theoretical constructs to a vivid, multi-billion euros case study. Previous studies on oil discoveries all point toward positive market responses, yet the size and swiftness in the case of Galp's response requires new exploration. This thesis sits in a special place at the intersection of a specific theoretical tradition and a noteworthy company event. Employing a careful event study approach, it considers the whether the market did incorporate value associated with the discovery in Namibia.

The findings offer robust evidence in favor of the market efficiency idea: the study finds an immediate and statistically significant AR in excess of 15% on announcement day and no significant evidence of information leakage. This suggests a market that reacted with remarkable speed and accuracy. Nevertheless, within the tradition of scholarly investigation, we also explore the restrictions and nuances of these conclusions, acknowledging the notorious difficulty created by model specification and the curious nature of positive returns that in future research could be explored under a behavioral lens.

This analysis goes beyond the academic world. For investors, it underscores the brutal efficiency of market forces, echoing the old saying that once news goes public, it is often too late to intervene. For business executives, it underscores the massive shareholder value created through efficient exploration and the essential role played by such announcements. For a country like Namibia, it underscores the transformative and potentially disrupting economic impact of discovering mineral deposits, a scenario often referred to as a “resource curse” that requires careful monitoring in order to avoid the travails faced by other nations (Sachs and Warner, 2001).

Following the thesis structure, the first chapter sets a theoretical background for this test by discussing fundamental concepts concerning market efficiency and event study methodology. A careful examination of the literature will also place this research in the context of the wider academic debate and identify the most appropriate methodological methods for measuring investor response to oil-based corporate announcements. After this literature review, Chapter 2 outlines the utilized data, its sources and statistical properties, while Chapter 3 describes the methodology. In Chapter 4 the results obtained from the event study are presented, which are then discussed in Chapter 5. Lastly, the conclusion summarizes the study and offers suggestions for further research.

CHAPTER 1

1. Theoretical Foundations and Literature Review

To better understand the academic research related to oil discoveries and the stock market, this section introduces relevant theoretical concepts along with prior studies in this area, providing context and highlighting issues with the testing that will be addressed in the methodology section. The literature review for this paper will be presented with the following structure:

It will start by presenting the theoretical foundation on which this analysis is built, the EMH, followed by an exploration of the Event Study methodology, the main empirical instrument to evaluate market responses to new information. The discussion will then move on to a review of previous research that evaluate the connection between oil-related events and prices on equity markets, addressing studies that have focused on analogous contexts and utilized event study methods to further illuminate their findings, shortcomings, and gaps that this thesis intends to fill.

1.1. Efficient Market Hypothesis (EMH)

Can financial markets accurately and immediately incorporate new information, such as major oil discoveries, into asset prices?

This is the central question behind the EMH, developed in the 1960s by Fama (1965a, 1965b) and Samuelson (1965), and originally formalized in the 1970s by Fama (1970, 1976). EMH proposes that financial markets are informationally efficient, i.e., that asset prices fully and instantaneously reflect all available information. This hypothesis is a fundamental principle of modern finance and supplies the theoretical basis for measuring the market response to new available information, such as oil discovery announcements, by applying event study methodology.

Fama (1970) distinguished three forms for EMH, based on the type of information assumed to be reflected in prices (Bodie, et al., 2005):

- Weak form: All historical information related to price and returns is already embedded in current prices. Therefore, it condemns the use of technical analysis, which relies on historical data to predict future prices, as ineffective.
- Semi-strong form: All publicly available information is immediately and accurately incorporated into stock prices. A significant event like a confirmed oil discovery should

lead to an immediate, unbiased adjustment in stock prices, consistent with rational market expectations.

- Strong form: Even private information is embedded in prices. However, according to Jensen (1978), the strong form is not usually seen by the research community as anything more than a theoretical extreme.

These forms are hierarchical in the way that semi-strong efficiency form assumes the weak form holds and the strong form efficiency considers that both the semi-strong and the weak form hold.

EMH in its weak form states that future prices on assets are not a function of historical prices. Why? Because if future price movements can be predicted, rational investors would act on this information until the opportunity for profit vanished (Bodie et al., 2005). In other words, any pattern observed by technical analysts should already be reflected in current prices. This concept has conventionally been at odds with theories that presume that price movements could be forecasted based on technical analysis as mentioned by Fama (1965b). Random Walk Hypothesis (RWH) defenders argue that price changes are by nature random and therefore cannot be predicted. The EMH can therefore be viewed as the theoretical foundation that justifies RWH.

Following the release of unexpected, pertinent information to the general public, the price adjustment that ensues should be instantaneous, facilitated by market demand and supply pressures. If there are delays in the dissemination of information or systematic misinterpretations, traders will be able to devise exploitative strategies to profit from anomalies and ultimately eliminate them (Fama, 1965a). Not only due to a broad base of investors seeking profit via arbitrage, but this realignment can also occur due to a few deep-pocketed institutional players (Schwert, 2003). Thus, ARs cannot be obtained through fundamental analysis in semi-strong efficient markets, and even insider trading would be non-profitable in strong form efficient markets.

Assumptions and Implications

So, is it not possible to “beat the market” by information-motivated trading?

That is correct according to EMH. When in an informationally efficient market, any excess return requires excess risk. This brings implications for the way financial markets should be approached when it comes to investment strategies. If the market is efficient, the use of index funds that aim to replicate market performance instead of beating it will outperform active portfolio management and stock picking in the long term (Malkiel, 2019; Bogle, 2017).

The validity of the EMH relies on the fulfillment of a few assumptions. Investors must process information rationally, updating their beliefs in line with Bayes' theorem[1] and making decisions in accordance with Subjective Expected Utility (Barberis and Thaler, 2003). EMH does not demand that all individual investors be rational. The requirement is that the market must function as if it were rational. Inheriting the assumptions behind arbitrage, such as the presence of arbitrageurs mentioned above, who have adequate resources and incentives to eliminate inefficiencies (Lo, 2012). EMH considers that this process can correct irrational behavior by some investors.

1.2. Tests for Market Efficiency

Most of the research on market efficiency still focuses on testing whether returns can be predicted or not, being semi-strong the most tested form of EMH. Although EMH per se cannot be tested directly, since the actual information set is unobservable, its empirical implications for the return-generating process can be tested. Fama (1970) reformulated the three forms of EMH in terms of their empirical implications. Empirical tests have since largely focused on:

Weak form: Considering how well returns can be forecasted based on past price movements. If returns are unpredictable, it supports the view that past information is already incorporated into current prices.

Semi-strong form: Measuring how quickly and accurately new available public information, such as corporate announcements, is incorporated into market prices.

Strong form: Addressing whether prices reflect non-public information by analyzing the ability of privileged individuals, i.e., corporate insiders or fund managers, to consistently deliver market performance above that of the overall market (Elton et al., 2009).

The empirical verification of the EMH began in the 1960s, with an increasing body of literature that has sought to establish or refute whether asset prices respond efficiently to new information, and, if so, the speed and correctness with which this takes place.

Fama (1965a, 1965b) and Samuelson (1965) proposed the notion of stochastic price movements as indicators of informational efficiency. The groundbreaking paper by Fama

[1] Bayes' theorem describes how prior beliefs are updated considering new evidence (Bayes, 1763).

(1970) synthesized theoretical perspectives and empirical observations into a consistent framework, provoking extensive research for decades to follow.

Subsequent research, such as Fama (1976), Brown and Warner (1985), and MacKinlay (1997), went on to refine the empirical methodology used in testing market efficiency.

Research by Brown and Warner (1985) and MacKinlay (1997) showed that stock prices adjust within a narrow window around significant announcements, in line with the EMH expectations. However, anomalies have questioned the strict interpretation of the hypothesis, and attention has increasingly shifted to behavioral explanations and market frictions.

1.2.1. Anomalies and Critiques to Market Efficiency Tests

Although the EMH has been a foundation of contemporary financial theory, it has also drawn persistent and considerable criticism from both theoretical and empirical perspectives. While many studies have established the general sensitivity of asset prices to new information (Easley et al., 2002; MacKinlay, 1997), posterior evidence has shown the presence of lags and visible trends in price adjustments, thus questioning the general applicability of the hypothesis (Busse and Green, 2002).

Behavioral Finance

One of the prominent critiques of the EMH was developed within behavioral finance research, which applies concepts of cognitive psychology to the analysis of financial decision-making. Writers like Thaler (1999) and Shiller (2003) argue that investors are not always rational and tend to make cognitive errors, such as overconfidence, loss aversion, and herding, which systematically influence asset prices.

To reconcile behavioral outcomes with market processes, Lo (2004) proposed the Adaptive Market Hypothesis (AMH). In contrast to EMH's continuous rationality and informational efficiency assumption, AMH suggests that markets evolve over time in response to environmental pressures, institutional change, and learning on the part of market agents. The adaptive perspective is helpful in explaining the presence of anomalies and periods of inefficiency without abandoning the overall framework of competitive markets.

Market Inefficiencies and Observable Trends

Momentum effects, as reported by Jegadeesh and Titman (1993), are the tendencies shown by stocks with good past performance to continue to outperform in the short to medium term, and this is an example of an anomaly that violates the hypothesis of price unpredictability and contradicts the notion that past price information should not have any power of prediction under the weak form of EMH.

There have also been some studies that revealed delayed reactions such as post-earnings-announcement-drift, described by Shivakumar (2007) as a well-documented anomaly, which suggests that markets do not always reflect new public information instantly.

Other empirical work shows that measures such as the price-to-earnings (P/E) ratio have the power to predict future returns. Shiller (2005), for instance, provided evidence indicating that low P/E ratios tend to be followed by high subsequent returns. If markets are indeed semi-strong efficient, then such correlations will not persist in the long term.

Real-world events like asset price bubbles, such as the dot-com bubble of the late 1990s, the housing bubble preceding the 2008 financial crises, and other crisis like the one caused by the Coronavirus pandemic in the early 2020s, show how sustained periods of irrational exuberance, herd behavior, and rapidly shifting investor sentiment can drive securities far from their intrinsic worth, standing out as evidence against the EMH.

A further avenue of critique examines how news are released and interpreted. Henry (2008) demonstrated that the phrasing of press releases can have a considerable impact on ARs, indicating that investor sentiment and subjective interpretation play a role in the speed and efficiency with which news is reflected in markets. The announcement timing was found to have an impact on its market impact, thereby rendering the assumption of immediate price adjustment tenuous.

Lastly, the strong version of EMH is compromised by overwhelming evidence on insider trading. Research like Haddock and Macey (1987) have reported that insiders consistently earn ARs, implying that non-public information is not completely incorporated into stock prices, a contrarian view to strong-form efficiency.

1.2.2. Event Studies as a Major Method of Testing EMH

Event study is one of the most significant instruments in the area of financial economics when it comes to testing market efficiency. The method consists of contrasting realized returns with a model-based benchmark of expected returns, and the resulting difference is known as AR.

When accumulated over a time period, these yield cumulative abnormal returns (CARs), a key metric for assessing market reaction. These metrics, popularized over 50 years ago with Fama et al. (1969), continue to be at the forefront of the event study methodology and are intimately associated with the semi-strong form of the EMH. These studies are most used to analyzing stock returns, though some researchers, less frequently, apply them to trading volumes and volatility patterns.

As McWilliams and Siegel (1997) explain, the goal of an event study is to determine whether an unexpected event leads to an abnormal change in stock prices. By isolating abnormal price movements that cannot be explained by general market trends, event studies provide a powerful empirical lens through which the semi-strong version of the Efficient Markets Hypothesis (EMH) may be tested. It enables researchers to take into account not only whether markets respond to new information, but also how quickly and whether the response is efficient, or if there is any delayed reaction.

While Fama et al. (1969) created the seminal approach, the origins of the event study methodology trace back to Dolley (1933), who studied the effect of stock splits on security prices.

The method has subsequently been refined considerably and has been used quite widely in a variety of fields of financial studies. Brown and Warner (1985) increased the statistical power of the technique by highlighting the use of daily returns and analyzing power and size tests under alternative model specifications. MacKinlay (1997) wrote about an overall methodological approach, whereas Kothari and Warner (2004) took into consideration additional subjects such as event bunching, selection of estimation windows, and low volumes of trading effects, all of which influence the validity and accuracy of research findings.

In reconciling distributional problems such as skewness and kurtosis in stock returns, non-parametric approaches were suggested by Corrado (1989, 2011), which offered more robust options compared to conventional parametric tests. Later innovations, as seen in Armitage (1995) and Breinlich et al. (2018), demonstrate the versatility of event studies in examining not just corporate announcements but also large-scale geopolitical and economic shocks.

1.3. Event Study: Assumptions, Models, and Challenges

Brown and Warner (1980, 1985) contend that event studies are based on three fundamental assumptions:

1. Stock returns during the event window reflect the economic impact of the event under consideration.
2. The event comes as a surprise and is not already reflected in the current stock price.
3. Within the specified event window, there are no extraneous occurrences that could account for the price fluctuations observed.

In the real world, it is very difficult to maintain these assumptions, especially in single-event studies such as this thesis, where the researcher must demonstrate that any AR discovered is caused by the event in question only.

The foundation of any event study is its expected returns model. This benchmark enables one to distinguish ARs that are allegedly attributable to the event. Statistical models are separated into two categories, single factor, and multi-factor models. Among the methodologies used for modeling normal returns, such as The Model of Constant Mean Returns and multifactor models like the Fama-French Three-Factor Model, the financial literature often identifies the Market Model (MM) as the most common methodology, particularly in event studies. MM is a single-factor linear regression model and is also a more general form of the Capital Asset Pricing Model (CAPM). While the CAPM[2] imposes more stringent theoretical assumptions (e.g., homogeneity of investors, mean-variance efficiency), the MM relaxes these without altering the underlying asset and market return relationship.

The MM successfully controls market-wide effects, assuming a linear stable relationship between market and asset returns for both the estimation period and the event period. However, it implicitly assumes time-invariant parameters and homoscedasticity (homogeneous variance), which may not be true in financial time series, particularly when the market has high volatility. For cases like this, the use of GARCH-enhanced MM conforms to the approach presented by Corhay and Tourani (1996), who illustrate that including time-varying volatility provides better estimates of ARs.

Dyckman (1984) demonstrated that in the oil and gas sector, failing to control for industry classification can significantly reduce the power of event study tests. Several studies have confirmed a high correlation between oil prices and the market value of oil companies (Jones and Kaul, 1996; Sadorsky, 1999; Kilian and Park, 2009). Firms influenced by the same changes in the economy tend to move together. Incorporating variables related to sectors and commodities into the process of determining returns reduces the remaining differences in ARs

[2] MacKinlay (1997) clarifies that while the (CAPM) is based on economic theory, the market model is based solely on statistical techniques and places no restrictions relative to the behavior of rational investors.

and, consequently, enhances the accuracy and power of hypothesis tests (Brown and Warner, 1985). MacKinlay (1997) says that the marginal gains from multifactor models are themselves typically very small because additional factors beyond the market index add little to the explanation. That may not hold true in one-firm, one-event studies. In those studies, because data from many firms cannot be pooled, it is of the utmost importance to specify a good model.

A key limitation of event studies employed for testing market efficiency is known as the joint-hypothesis problem. Fama (1991) explains that any test of market efficiency will automatically also test for both the EMH and for the asset-pricing model that is used for estimating normal returns. The ARs that result will therefore either represent a market-efficiency deficiency or a misspecification error of the return model. This challenge highlights the need for the selection of models and encourages the utilization of day-to-day data to more accurately estimate the degree and the speed of price adjustment to new information.

This dissertation follows well-established methodology as presented by MacKinlay (1997) but also observes best practices from contemporary literature. The step-by-step description of the procedures to be implemented is presented below.

1. Identify and establish the event date.
2. Define the event window(s).
3. Define the estimation window.
4. Estimate the normal return model through Ordinary Least Squares (OLS) estimation of the MM or extended versions.
5. Compute ARs for each day in the event window.
6. Cumulate ARs into CARs for the given windows.
7. Perform statistical tests on ARs and CARs for significance.
8. Conduct robustness tests with different windows, benchmarks, and models.

Some methodological issues may be of concern in event studies, namely non-normal distribution of returns, event-induced volatility, cross-sectional dependence, and distortion of results from overlapping or unrelated news (Kothari and Warner, 2004). These issues are especially severe in studies of announcements of resource discoveries or news pertaining to firms in emerging economies, where trading volumes are thin, investor bases are shallow, and informational asymmetries are high.

Furthermore, the exogeneity of the event should be correctly tested. If the event is anticipated or even partially expected, either due to information leakage or to speculative trading, then the ARs one can observe might not accurately reflect the market's genuine reaction.

The above issues will be addressed in the empirical setup provided in the Methodology chapter. In these cases, conducting robustness checks based on different horizons or models and qualitatively verifying the news cycle becomes critical.

The event study methodology remains a key method for analyzing the way that financial markets digest information. Within the context of this thesis, this model will be applied in order to ascertain if the news of Galp's oil find in Namibia was rapidly and effectively reflected in the company's share price, providing empirical insight into the level of informational efficiency in this particular market environment.

1.4. Previous Research

This subsection aims to provide a comprehensive review of literature that empirically examines the relationship between oil discoveries and equity market performance. The goals are to place the current research within the broader academic literature, to identify established findings, and reveal known questions or gaps in past research that are to be addressed by this paper.

The intersection between natural resource discoveries and financial markets has been studied from a range of perspectives, usually focusing on issues like market efficiency, investor sentiment, and the wider macro-financial effects. However, the direct effect of oil discovery announcements to the companies' shares involved in such discoveries continues to be under-researched, particularly ones focused on frontier markets and single-event analyses, such as the Galp Energia discovery in Namibia's offshore area.

1.4.1. The Effect of Oil Discovery Announcements on Stock Prices

The literature reviewed below is organized according to the level of analysis adopted in each study, starting with macroeconomic and multi-country approaches, moving to sector-level research, and concluding with firm-specific investigations. For each level, two studies are discussed, chosen for their methodological relevance and contribution to understanding how markets react to oil related news.

The first group of studies adopts a broad macroeconomic or multi-country perspective, analyzing the stock market implications of large oil discoveries across nations. Arezki et al. (2017), investigates the macroeconomic and financial implications of giant oil discoveries across 33 countries over the past decades. They conclude that such discoveries have a significant impact on the performance of the stock market, suggesting that oil-related events act as a “news shock” that has both real and financial effects. However, their study is mainly at the country level, thus ignoring firm-level factors and the microstructural differences present in individual equity responses.

Complementing this macro view, Leinert (2012) outlines a sophisticated methodology that focuses on the efficiency of market tests with respect to oil field discoveries. A multi-event research design is applied to demonstrate that the responses of oil prices are not always optimal, and there are examples of underreaction in certain circumstances. Such findings suggest the presence of inefficiencies that could be related to information asymmetry, investor inattention, or the uncertain commercial value of the discoveries at the time of the announcement. The study combines several events over different companies and economies and raises concerns about the external validity within a single corporate situation, like that of Galp.

A second stream of research focuses on sectoral dynamics, typically analyzing how reserve changes or oil news affect the valuation of oil and gas companies as a group. Equiza-Goñi (2020) examines the effect of proven reserves change upon equity returns in the United States oil and gas sector. The result reveals a positive and significant statistical relationship and indicates that the market values new information related to the availability of resources, especially when the information relates to tangible, commercial outcomes. His tightly methodologically designed research, with endogeneity and structural break controls, sets a standard for careful empirical work in the field of oil finance.

Karali et al. (2018) contributes to this literature by applying a Mixed Event Response Model to crude oil futures, highlighting the complex interplay between speculation, macro-news, and structural breaks. Although focused on futures markets rather than equity prices, their methodological innovation offers valuable insights for modeling non-linear and time-varying reactions to oil-related announcements.

Finally, a set of studies focuses on the firm level data, often analyzing the market impact of single announcements or specific types of oil-related news. Misund (2018) examines the effect of reserve purchases compared to the pursuit of exploration activities upon firms' valuations. Using an event study methodology applied to a dataset of publicly listed oil and gas companies from 1996 to 2014, the paper measures abnormal stock returns in short event windows surrounding announcements of either reserve acquisitions or exploration successes. The findings suggest that exploration-related announcements provide more ARs compared to announcements related to acquisitions. This result can be explained by taking the speculative and risk-reward nature of such activities into account, particularly when viewed as a key element of a firm's strategic growth, such as Galp's venture in Namibia.

Alsalman (2023) examines the influence of oil news shocks upon the US stock market using a structural vector autoregression (SVAR) framework with daily data from major oil and equity indices between 2000 and 2020. The approach contributes to the literature by differentiating between different types of oil news shocks (geopolitical, exploratory, and macroeconomic) and understanding their importance to investors by analyzing their effects on stock returns. The results provide evidence of asymmetric reactions and the long-term persistence of ARs, with exploratory news generating significant short-term stock market movements, a finding directly relevant to the Galp Namibia context.

Collectively, the literature base supports the claim that oil discovery, especially when unexpected, involves large reserves, or alters a firm's strategic framework, can cause both statistically and economically significant fluctuations in share values. However, research is not able to provide conclusive insight into the consistency and determinants of such reactions, particularly in newly emerging or frontier markets where there are underdeveloped financial market infrastructures and investor bases.

1.4.2. Gaps in Literature

Despite the expanding body of research in this area, there are some limitations that this thesis aims to overcome. Firstly, there are relatively few single-event studies that solely focus on market reaction to one and only one highly impactful oil discovery by a listed firm, especially in the case of a frontier market such as Namibia. Single-event studies are more susceptible to idiosyncratic variations with respect to methodology but are uniquely positioned to examine firm-specific dynamics at a more nuanced level, especially when the event is of considerable consequence and strategic significance.

Secondly, much of the current literature focuses either on advanced markets or composite indices. Not much research has considered the reaction of European mid-cap energy firms that are expanding to new geographical markets. The case of Galp Energia exploration activities in Namibia presents a new insight with which to analyze how investors value the nexus between exploration risk, geopolitical uncertainty, and potential strategic development.

Thirdly, there is a noticeable absence of emphasis on the volatility dynamics of these announcements. Is the information being absorbed by the market immediately, or is there evidence of underreaction or drift in ARs? Do oil discoveries raise information asymmetry and thereby increase post-announcement volatility? These questions are the empirical thrust of this thesis.

In conclusion, prior research tends to ignore some institutional and behavioral factors, such as the extent of media coverage, investors' sentiment, and the type of regulatory disclosure, which may be affecting the market reaction to new information. In the case of Galp, the way that the market perceives its credibility and operational capacity to develop the discovered fields should be better explained to clarify the price movements.

CHAPTER 2

2. Data

The purpose of this chapter is to briefly outline the dataset used with the goal of examining Galp Energia's stock valuation reaction to its public announcement of an offshore oil discovery in Namibia (April 21, 2024). Being one of Portugal's largest listed firms and a major shaper of the Portuguese Stock Index (PSI, formerly known as PSI20), the announcement also has implications for the wider national market situation in Portugal.

The primary objective of preliminary data analysis is to examine statistical properties of variables before performing an event study. This chapter specifically includes a descriptive statistics summary, visual illustrations, pairwise correlation tests, and stationarity tests (through application of the Augmented Dickey-Fuller test) for each series under investigation.

This section sets the stage for subsequent analysis by clearly defining variables, data sources, and temporal structures used in the event study.

2.1. Data and sources

The financial time series data used here consist of variables that have an inherent connection to the research question itself. Daily closing stock price data for Galp Energia, listed on the Euronext Lisbon exchange with ticker symbol GALP.LS, as well as market indices, were obtained from Yahoo Finance. The indices selected are the PSI, representing the Portuguese stock market, ticker symbol PSI20.LS and the STOXX Europe 600 Oil & Gas (hereafter also referred to as sectoral index), represented by the ETF proxy iShares STOXX Europe 600 Oil & Gas UCITS ETF (DE) with ticker symbol EXH1.DE, representing the European energy sector to capture industry dynamics and investor sentiment toward energy stocks. Additionally, daily Brent crude oil prices were retrieved from the same platform, ticker symbol BZ=F serving as a proxy for global oil market fluctuations. All financial data were adjusted for dividends and stock splits where applicable and expressed in local currency (EUR) terms.

To analyze asset price dynamics, daily log returns were calculated for each series. The log return r_t at a time t is defined as:

$$r_t = \ln\left(\frac{P_t}{P_{t-1}}\right), \tag{2.1}$$

where P_t and P_{t-1} represent the adjusted closing prices at days t and $t-1$, respectively. Log returns provide several advantages over simple returns. They are time-additive and improve statistical properties for econometric analysis. Consequently, the analysis below (correlation analysis, volatility measurement, and event studies) was applied to Galp Energia, PSI, STOXX Europe 600 Oil & Gas, and Brent crude oil log returns.

2.2. Time Periods

The data includes a significant time span of 281 trading days from February 2023 through May 2024. Throughout the analysis, the term *trading days* refers to days for which valid return observations are simultaneously available for all series considered. This differs slightly from the full calendar of market trading days, as the days with missing data in any series were excluded.

The daily price time series for Galp Energia, PSI, sectoral index, and Brent crude oil are illustrated in Appendix A: Daily closing prices of Brent crude oil from April 2023 to May 2024. through Appendix D: Daily closing levels of PSI from April 2023 to May 2024., while the log returns series for the same variables are presented in Appendix E through Appendix H and Figure 2.1 below:

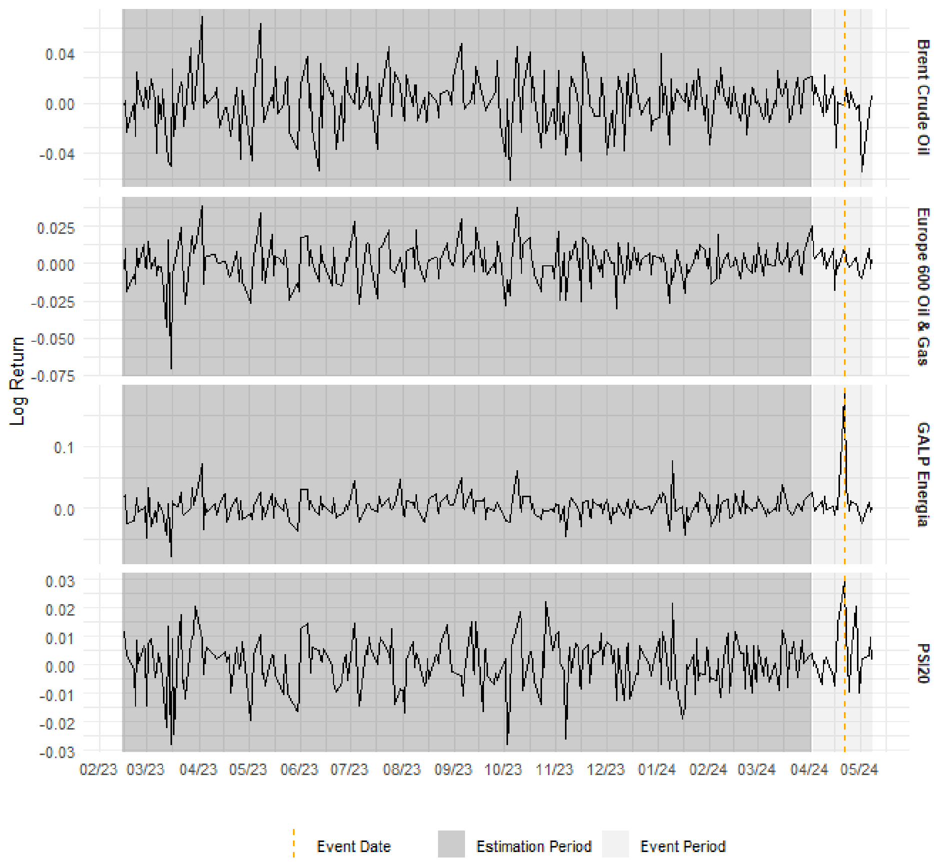


*Figure 2.1: Stacked daily log returns of Galp Energia, PSI, STOXX Europe 600 Oil & Gas, and Brent crude oil. **Source:** Own elaboration based on Yahoo Finance data.*

Three different temporal intervals are utilized:

The estimation period includes 250 trading days prior to the event window, corresponding to the period from February 14, 2023, to April 2, 2024 (Figure 2.2: Simplified event study timeline Source: Own elaboration.). This period is used to estimate the expected relationship between Galp's returns and the returns of the PSI, the sectoral index, and Brent crude oil. This relationship is estimated under the assumption that no event occurred during this time. When determining the estimation window, there is a trade-off between statistical efficiency and the possibility that the company's risk has changed over time. Here I will follow the convention of using about a year's worth of trading days, which is also recommended by MacKinlay (1997).

The event of interest is the announcement of Galp's oil discovery in Namibia, which was officially made public on Sunday, April 21, 2024. Given that markets are closed on Sundays, the first trading day following the announcement, Monday, April 22, 2024, is considered the effective date (t = 0).

The main event window spans from t = -10 to t = +10 trading days (April 3 to May 9, 2024), capturing pre-event anticipation effects as well as short-term post-event adjustments (Figure 1). To assess the robustness of results, alternative event windows such as [-5, +5], [-3, +3], and [-1, +1] will also be examined.

A third window covering the period from 2012 to 2025 is used for contextual verification. This long-term window allows for the identification of any relevant regulatory, environmental, or corporate developments that could confound the results of the event study. A review of Galp's official communications and Namibian regulatory updates confirms that no major announcements or external shocks occurred around the event date that could bias the results. Furthermore, the announcement on April 21, 2024, seems to have caught the market by surprise, supporting the validity of treating it as an exogenous and isolated event.

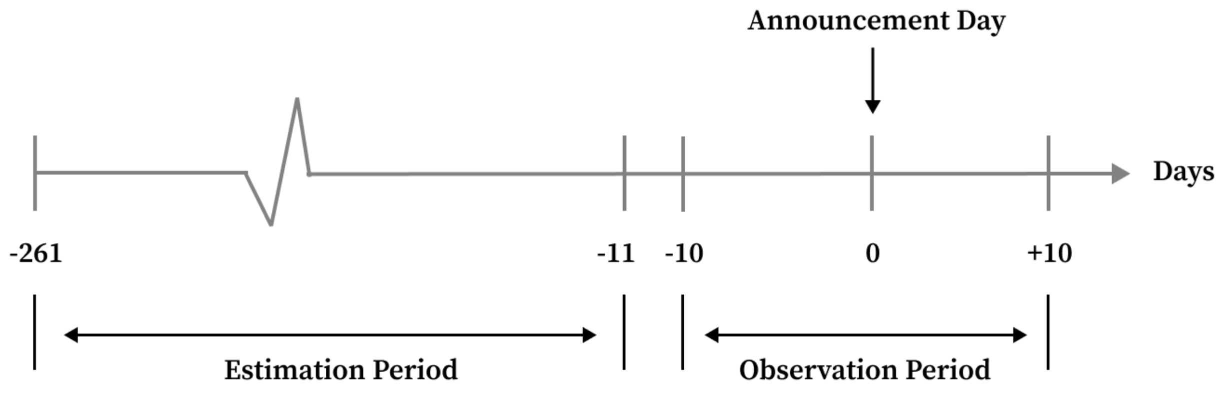


Figure 2.2: Simplified event study timeline Source: Own elaboration.

2.3. Statistical Properties

Before proceeding with the event study, it is necessary to check the statistical properties of the return series since the integrity of the econometric estimates relies on the data's behavior. The dataset includes 281 daily observations pertaining to the returns on Galp Energia's stock, PSI, STOXX Europe 600 Oil & Gas index, and Brent crude oil prices. The sample did not include any missing values (NAs), guaranteeing the reliability and validity of the data utilized.

Table 2.1 presents the main descriptive statistics related to daily log-returns of the variables mentioned above during both event and estimation periods. The estimation sample shows that all series have means of returns that lie around zero as expected in financial time series analysis. GALP Energia has a relatively high sample average return of 0.14% relative to the remaining assets. The standard errors indicate that Brent and GALP are by far the most volatile among those under study, whereas PSI shows the lowest variability among all four series. The statistics for skewness and kurtosis show wide departures from normality; more precisely, GALP shows high right skewness and excess kurtosis, whereas Brent and the sectoral index suggest fat tails with related negative skewness.

Table 2.1: Descriptive Statistics of returns

Series	Period	Mean	Median	SD	Min	Max	Skewness	Kurtosis
Brent	Estimation	0.014%	0.143%	2.050%	-6.12%	6.83%	-0.148	3.64
Brent	Event	-0.300%	-0.158%	1.710%	-5.51%	2.27%	-1.56	5.96
GALP	Estimation	0.144%	0.079%	1.790%	-7.71%	7.73%	0.214	6.37
GALP	Event	1.160%	0.121%	4.270%	-2.48%	18.40%	3.53	15
PSI20	Estimation	0.028%	0.091%	0.872%	-2.81%	2.20%	-0.444	3.5
PSI20	Event	0.322%	0.165%	0.995%	-0.98%	2.92%	1.02	3.76
Sectoral Index	Estimation	0.024%	0.035%	1.280%	-7.02%	3.92%	-0.665	6.78
Sectoral Index	Event	0.103%	0.223%	0.762%	-1.82%	1.11%	-0.708	3.23

Source: Own elaboration

The Jarque-Bera tests (results available on Appendix J) offer statistical confirmation for the existence of non-normalities: for GALP and the STOXX Oil & Gas index, the null hypothesis that normality holds is strongly rejected at both estimation and event windows ($p < 0.01$). The PSI and Brent indices have marginal or non-rejections in the event window; however, as a set, they cannot be labeled as normally distributed. The results reinforce conventional assumptions in event studies and volatility modeling that imply that financial returns have non-Gaussian features, meaning they deviate from the characteristics of a normal distribution.

The stationarity of the returns was tested using the Augmented Dickey-Fuller (ADF) and KPSS methods (Appendix K). The results reflect agreement between both analytical methods:

the ADF tests reject the null hypothesis that a unit root exists ($p < 0.01$), while the KPSS test fails to reject level stationarity ($p > 0.1$). It is reasonable to conclude that all the series of returns are stationary, thus confirming their suitability in regression-based event study models.

The Box-Ljung test, conducted with 10 lags, to capture short-term dependence over a two-week trading period without diluting the test's statistical power, finds no evidence of autocorrelation among the returns on all series under study (p-values larger than 0.26 as seen in Appendix L). This result is as one might expect under the weak form market efficiency hypothesis. Tests of conditional heteroskedasticity (ARCH-LM, also using 10 lags for consistent focus on short-term volatility clustering) show us that: although GALP, Brent, and STOXX indices do not show significant ARCH effects, PSI exhibits such effects ($p < 0.01$) (Appendix M). This result signals the existence of time variation in volatility in PSI, a feature commonly seen at index level, and a need for models accommodating heteroskedasticity, e.g., GARCH-type forms, to perform robustness analysis.

The correlations built between the series and presented on Appendix I below uncover significant co-movements between GALP Energia and the sectoral index, measured at 0.65, and between GALP and PSI, measured at 0.54. The positive co-movement found between GALP and Brent is relatively low, at 0.41, indicating that GALP returns are affected somewhat by oil price fluctuations; however, this effect is partly offset through sectoral and general market factors. The relatively low correlation of 0.21 between Brent and PSI supports that oil price disruptions affected the Portuguese market mainly through GALP and not the index in general. These results effectively show that GALP's operational behavior is closely interlinked with its sectoral benchmark and foreign oil prices, but also to some extent with domestic market conditions.

These empirical properties have an impact on the interpretation of results and the efficacy of the methods utilized. The returns display stationarity characteristics, lack of autocorrelation, significant departures from normal distribution, and evidence of heteroskedasticity. The correlation dynamics found show that GALP enjoys a strong relationship with the industry sector and with the Portuguese market while exhibiting a modest sensitivity to changes in international oil prices.

The high levels of skewness and kurtosis in GALP returns and the frequent rejection of normality in many data series highlight the risk of asymmetric and extreme reactions to firm-specific news. This is in line with the models utilized in event study methods for the identification of ARs not explained by typical market or sectoral patterns.

The occurrence of non-Gaussian distributions implies that the use of t-distributions in their standard form can result in unreliable inference, thus highlighting the need for resilient statistical methods. The lack of autocorrelation in returns prevents the creation of identifiable patterns that may weaken the validity of measures of abnormal performance. The discovery of heteroskedasticity highlights the need to use resilient testing techniques to safeguard hypothesis tests from the effects of volatility clustering, thus increasing the accuracy of estimated ARs. The overall correlation framework highlights the need to embrace a firm-specific approach. GALP's returns have a strong correlation with both the PSI and the European Oil & Gas index but a moderate correlation with Brent crude oil. It can be concluded that the ARs during the event period are more influenced by the idiosyncratic effects of the announcement of this oil discovery itself and not by changes in market or commodity prices. In aggregate, these results support the event study approach and substantiate that the chosen design is correctly set up to clarify the effect of this announcement regarding the discovery on GALP's share price.

CHAPTER 3

3. Methodology

This research employs the event study method to analyze the effect of Galp's oil discovery announcement in Namibia on the company's stock valuation. As argued in the literature review, announcements concerning a company are capable of challenging the semi-strong form of the EMH. To examine this empirically, we measure the ARs around and on the event date and determine the magnitude and statistical significance of the reaction of the stock market, using a rigorous implementation in the R programming language.

In accordance with MacKinlay's framework (1997), this thesis's procedural foundation and Methodology chapter is divided into four parts: the first subsection is the definition of the event and estimation windows, the second concerns the modeling of expected returns, the third covers the calculation of AR and CAR, and, finally, the fourth subsection explains the test statistics used to evaluate the significance of the ARs.

3.1. Event study timeline

To implement the methodology correctly, it is essential to organize the analysis based on two key time periods, which include the estimation window and the event window. The estimation window is used to estimate the parameters of the normal return model. It must be sufficiently distant from the event so as not to be contaminated by anticipation effects or by information leakage.

In accordance with Armitage (1995), who concluded that results do not differ regardless of the estimation window used, provided it has more than 100 trading days, and in line with the recommended by MacKinlay (1997), an estimation window of [-261, -11] trading days surrounding the event date, corresponding approximately to a year's trading days, was adopted in this research (Figure 2.2).

The event window is the period during which we expect the stock to react to the announcement. For more robust results this thesis uses a number of event windows. This is to capture both immediate as well as slightly delayed market reactions, [-1, +1], [-3, +3], [-5, +5], and [-10, 10]. These windows are standard in literature and allow the researchers to test for the timing and length of market reactions.

The choice to use a short-horizon event study is based on empirical and theoretical grounds. While it has become increasingly possible in recent years to conduct long-horizon event studies covering several years due to methodological advances (Kothari and Warner, 2006), they remain exposed to confounding events, model misspecification, as well as autocorrelation of returns. Short-term studies, however, enable the effect of the event to be more precisely defined and are more commonly used for examining single corporate announcements, such as oil discoveries.

3.2. Market Model

Precise estimation of expected (or "normal") returns constitutes an essential element of event study methodology. A properly specified expected return model improves the accuracy of AR measurement by diminishing the variance of the residuals. This, in turn, increases the statistical power of hypothesis tests. Proper model specification also alleviates biases that degrade the quality of inference.

3.2.1. Standard and multifactor market models

As asserted by MacKinlay (1997), the MM is the most satisfactory and statistically efficient method of isolating firm-specific effects from overall market trends. In a comprehensive meta-analysis, Holler (2014) states that nearly 80% of all event studies published in the literature use the MM, and merely 4% use multi-factor alternatives, thereby underlining the empirical tractability and relevance of the model.

The standard representation of the MM is given as:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \,, \tag{3.1}$$

where R_{it} is the return on stock i on day t, R_{mt} is the return of the market index on day t, α and β are firm-specific intercept and slope coefficients, respectively, ε_{it} is the error term, assumed to be normally distributed with constant variance and zero mean.

The market return R_{mt} is typically proxied using a representative market index. Given that this study focuses on a Portuguese company, the PSI will be used, consistent with international practice (Campbell et al., 2010), which recommends local indices to reflect relevant market dynamics.

Given that the context of the current research is Galp Energia, a firm whose business activities are strongly based in the petroleum exploration sector, a multifactor model is proposed with a view to enhancing the explanatory power of normal return estimates.

When the benchmark model is miss specified, it will result in incorrect estimates of ARs and misleading conclusions in statistics. The multifactor model is used not just for improving predictions, but for reducing the omitted variable errors in the normal return estimates as well (Barber and Lyon, 1997).

Single-event studies are particularly sensitive to model assumptions as they are based on time-series as opposed to cross-sectional data. Boehmer et al. (1991) are of the opinion that using multifactor models in these instances can decrease skewness in the distribution of ARs, which leads to parametric tests being superior. Corrado and Truong (2008) also stress the use of robust statistical methodologies in single-event studies.

The multifactor market model is as follows in linear form:

$$R_{it} = \alpha_i + \beta_{iM} R_{Mt} + \beta_{iO} R_{Ot} + \beta_{iI} R_{It} + \varepsilon_{it}\,, \tag{3.2}$$

where R_{it} is the return on stock i on day t, R_{Mt} is the return of the market index on day t, R_{Ot} is the return on the price of crude oil on day t, R_{It} is the return on the industry index on day t, α is the intercept term for stock i and β_{iM}, β_{iO}, and β_{iI} are sensitivities of the stock return to the market, oil price, and industry index, respectively. ε_{it} is the error term, assumed to be independent and identically distributed (i.i.d.) with zero mean and constant variance.

The expected return models' parameters are termed the intercept α and the slope coefficient β. OLS estimates these two during the estimation period. This is the standard method reported by MacKinlay (1997). It assumes that the residuals are i.i.d., and that they possess a constant variance.

If these assumptions are not met, we will use corrections like Newey-West robust standard errors to make our inferences accurate and fair.

3.2.2. Market model with GARCH extensions

In order to address conditional heteroskedasticity, i.e., when the variance of the error term is time-varying, the simple MM is enhanced with a Generalized Autoregressive Conditional Heteroskedasticity (GARCH) specification. This is particularly true for the case of event-driven or high-frequency data, which is prone to volatility clustering.

The GARCH(1,1) specification, following Bollerslev (1986), defines the conditional variance h_t as:

$$h_t = \omega + \alpha \varepsilon_{t-1}^2 + \beta h_{t-1}\,, \tag{3.3}$$

Making this part of the market model enables the dynamic evolution of volatility in reaction to previous shocks and lagged variances. Though the GARCH model addresses constant variance assumptions, it fails to distinguish between the effect of positive and negative shocks on volatility. Yet, leverage effects, originally observed by Black (1976), demonstrate that negative shocks (e.g., bad news) cause higher increases in volatility than positive shocks of the same magnitude. The asymmetry in this effect is common in equity markets and has important implications for risk response and modeling. To offset these asymmetries, the model is additionally improved by employing the utilization of the Exponential GARCH (EGARCH) model formulated by Nelson (1991).

The EGARCH(1,1) model explains the logarithm of conditional variance as:

$$\log(h_t) = \omega + \beta \log(h_{t-1}) + \gamma \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} + \alpha \left(\left| \frac{\varepsilon_{t-1}}{\sqrt{h_{t-1}}} \right| - \sqrt{\frac{2}{\pi}} \right), \tag{3.4}$$

This formula enables the conditional variance to respond differently to shocks, and this ability serves to demonstrate nonlinear and leverage effects in the behavior of stock prices during events. Studies, like that of Matei (2009), demonstrate the significance of this advancement in applications in finance.

The GARCH and EGARCH (1,1) specifications were used instead of higher order alternatives because they offer the most efficient balance between parsimony and explanatory power. While more complex structures could, in theory, capture additional lags of volatility, empirical evidence shows that higher orders tend to generate overfitting and estimation instability. For this reason, GARCH (1,1) has become the standard benchmark in financial econometrics

Adding GARCH or EGARCH structures to the multifactor model would not be methodologically appropriate. The inclusion of volatility dynamics in this model, with only 250 observations, would increase substantially the number of parameters, leading to convergence issues, weak statistical power, and unreliable inference.

For EGARCH and GARCH models, parameters are estimated under Maximum Likelihood Estimation (MLE) as they are appropriate for models with time-varying volatility.

To correctly grasp the possible effects of the event in question, various types of models are used in estimation of anticipated returns. To make results valid and truly reflect the manner in which stock returns behave, four types of the MM are used in this research:

1. The standard MM.
2. A Multifactor Market Model, incorporating an industry-specific index and the international crude oil price as additional explanatory variables, to control for sectoral effects and commodity-driven shocks.
3. The MM with GARCH extension, to address conditional heteroskedasticity and time-varying volatility in the error term.

4. The MM with EGARCH extension, to capture potential asymmetries in volatility responses.

3.3. Calculation of Abnormal and Cumulative Abnormal Returns

ARs represent the difference between the observed stock returns and the expected return based on an asset pricing model. They are central in event studies since they enable researchers to see the impact an event, like an announcement of an oil discovery, has on stock prices without normal market volatility getting in the way. By showing how actual returns differ from expected returns, ARs allow us to know how well or poorly the asset is performing compared to the market.

ARs are calculated using the MM, either in its standard form or in an extended (multifactor) specification that incorporates additional risk factors. In the single-factor form, AR are defined as follows:

$$AR_{it} = r_{it} - \left(\hat{\alpha} + \hat{\beta}_i r_{mt}\right), \tag{3.5}$$

where AR_{it} is the AR for firm i on day t, r_{it} is the observed return of firm i on day t, $\hat{\alpha}$ and $\hat{\beta}_i$ are the estimated parameters from the MM, and r_{mt} is the return of the market index on day t.

The estimation of $\hat{\alpha}$ and $\hat{\beta}_i$ is conducted during the estimation window. Once obtained, they are applied to the event window to calculate the expected returns under normal conditions. This formulation is consistent with the MM, where the residuals in the event window (ε_{it}) are interpreted as ARs.

There are two major ways of compounding ARs in literature: CAR and Buy-and-Hold Abnormal Returns (BHAR). According to Loughran and Ritter (1995) and Fama (1998), BHAR is more appropriate for long-term studies, while CAR is more suitable for short-term studies. Due to the fact that this thesis is studying the short-term market reaction to the announcement of oil discovery, the CAR method is chosen as the most suitable method of measurement.

CAR aggregate discrete ARs over a given time interval to reveal the net impact of an event on a company's stock price. The CAR method is used extensively in order to view how effectively markets take advantage of new information and to examine the semi-strong form of the EMH, as noted by Kothari and Warner (2008).

CAR is calculated as the sum of ARs over the event window, typically defined from T_1 to T_2. In the context of this study, the event day is denoted as $T = 0$, and the event window defined relative to this date. When considering an event window, e.g., $[T_1, T_2] = [-5, +5]$, the CAR corresponds to the cumulative impact from five trading days before the announcement until five trading days after. Formally:

$$CAR_i(T_1, T_2) = \sum_{t=T_1+1}^{T_2} AR_{it} \ , \tag{3.6}$$

In cross-sectional or firm multiple event analyses, Average Abnormal Returns (AAR) and Cumulative Average Abnormal Returns (CAAR) are typically computed in an effort to discern systematic patterns of behavior in the market. As this study is a single firm, single event study, the AR are merely AAR and CAR equals CAAR. The significance of these measures will be verified in the following section, employing both parametric and non-parametric testing to ensure the results are reliable and robust.

3.4. Statistical Testing

The discussion by the authors of event study's test statistics is very specific, as are the different significance tests. Testing for ARs and CARs is crucial to ascertaining whether or not the response of the stock price to the event differs from that which would take place in normal market conditions.

Since this study involves just one firm and one event, it focuses on observing how ARs for the individual security change over time, not multiple firms as a group.

3.4.1. Parametric Testing

To test the null hypothesis that the expected AR is zero, standard t-tests are employed. The time-series t-test examines whether the mean ARs over the event window are significantly different from zero, based on the standard deviation of the estimation window residuals. This is computed as:

$$t(\overline{AR}) = \frac{\overline{AR}}{\frac{\hat{\sigma}_\epsilon}{\sqrt{N}}} \ , \tag{3.7}$$

where $\overline{AR}$ is the sample AR, $\hat{\sigma}_\epsilon$ is the standard deviation of residuals from the estimation window of the MM (or its extensions, such as GARCH or Multifactor Market Model), and N is the number of observations in the event window.

For the CAR over an event window $[T_1, T_2]$, the test statistic is computed as:

$$t\left(CAR_{[T_1,T_2]}\right) = \frac{\sum_{t=T_1}^{T_2} AR_t}{\sqrt{(T_2 - T_1 + 1)} * \hat{\sigma}_\epsilon} \ , \tag{3.8}$$

This specification presumes residuals from the estimation model to be normally distributed and i.i.d. and ARs to be i.i.d. with constant variance. If the null hypothesis is true, both test statistics follow a t-distribution with $N - 1$ degrees of freedom, which allows determining the critical value and deciding whether to accept or reject the null.

3.4.2. Nonparametric and Robustness Checks

However, the assumption of normality may not hold, especially for high-frequency financial returns or near large events, where volatility and return distributions are likely to be skewed or leptokurtic. For this reason, then, nonparametric tests are suggested as robustness checks. The generalized sign test, for instance, examines if the sign of ARs surrounding the event date is persistently positive or negative, without assuming any distribution.

In addition, bootstrapping techniques can be used to estimate the distribution of test statistics under the true null hypothesis. Resampling is especially helpful in single-event studies since it allows us to make conclusions without making strong assumptions and can handle possible time-related dependencies in the data.

Because of single-event inference's weaknesses, like being more vulnerable to random noise, these other approaches are required to render the conclusions more robust. Using both parametric and nonparametric methods follows the advice in the literature (Kothari and Warner, 2007; MacKinlay, 1997) to make hypothesis testing robust even without the availability of cross-sectional data.

CHAPTER 4

4. Empirical Results

4.1. Abnormal and Cumulative Abnormal Returns (AR and CAR)

4.1.1. Abnormal Returns (Sample Evidence)

The event analysis demonstrates that the stock price of Galp saw drastically high positive ARs, as seen in the Figure 4.1 below, near the announcement made on April 21, 2024, of the oil discovery in Namibia. Additional figures covering alternative event windows are presented in Appendices Appendix N and Appendix O, in Figure 4.2: Abnormal Returns for the event window (-1, +1) Source: Own elaboration, and the associated tables with the raw data used for the visualizations in this sub section can be consulted in Appendices Appendix S - Appendix Y.

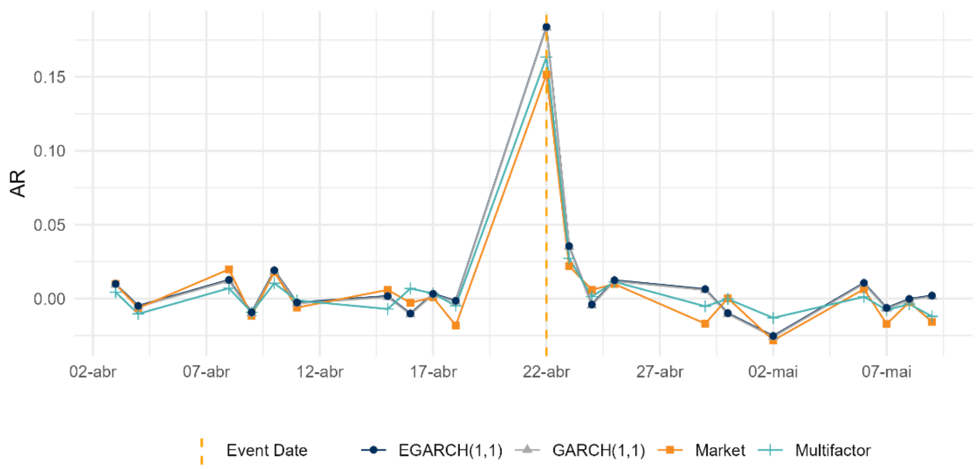


Figure 4.1: Abnormal Returns for the event window (-10, +10) Source: Own elaboration

In an array of model specifications such as the standard MM, MM with EGARCH(1,1) errors, MM with GARCH(1,1) errors, and Multifactor MM, the ARs on the first trading day after the event day are strongly positive, ranging from +15.1% (MM) to +18.4% (EGARCH). This return is highly significant relative to normal earnings or macroeconomic announcements, illustrating the idea that the market valued the discovery as an incredibly useful piece of information.

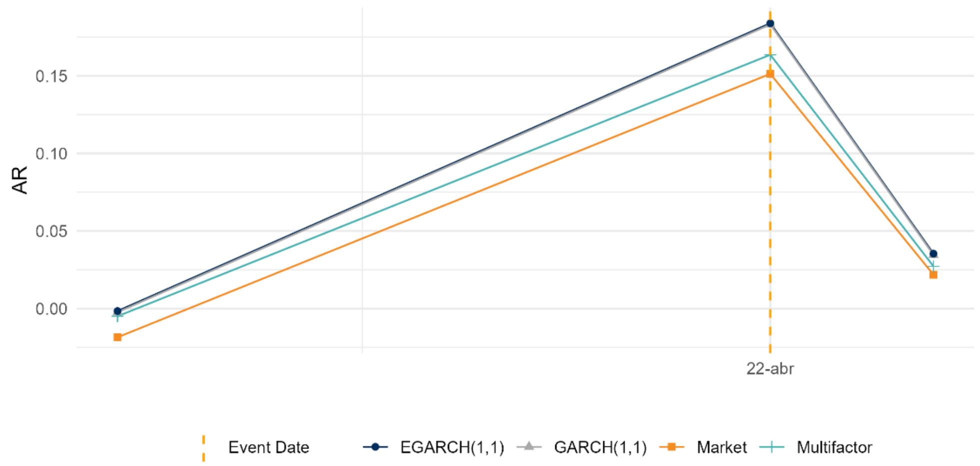


Figure 4.2: Abnormal Returns for the event window (-1, +1) Source: Own elaboration

As presented by Figure 4.2 above, in the days immediately before and after the event, the evidence is more mixed. On April 18, 2024, before the announcement was officially made, the ARs are slightly negative across models (e.g., -0.16% on EGARCH, -2.4% on GARCH, and -1.85% on the MM). This is indicative of no strong evidence for information leakage, as the impact is minimal in magnitude and not uniform in direction. On the second post-announcement trading day (April 23, 2024), the ARs are still positive but substantially smaller; between +2.1% (MM) and +3.5% (EGARCH), typical for the short continuation of market optimism rather than for delayed responses.

Over longer pre-event horizons (-3, +3; -5, +5; -10, +10), the measured ARs are rather noisy but not with any systematic positive direction towards the event. In the (-10, +10) interval, for example, fluctuations on April 8 and April 10 (ARs larger than +1.9%) seem event-unrelated, given the very rapid decay. This offers preliminary support that the spike observed on April 22 is closely associated with the discovery announcement.

4.1.2. Cumulative Abnormal Returns (Sample Evidence)

The CARs confirm the evidence for an abrupt, large change in the value of Galp's equity.

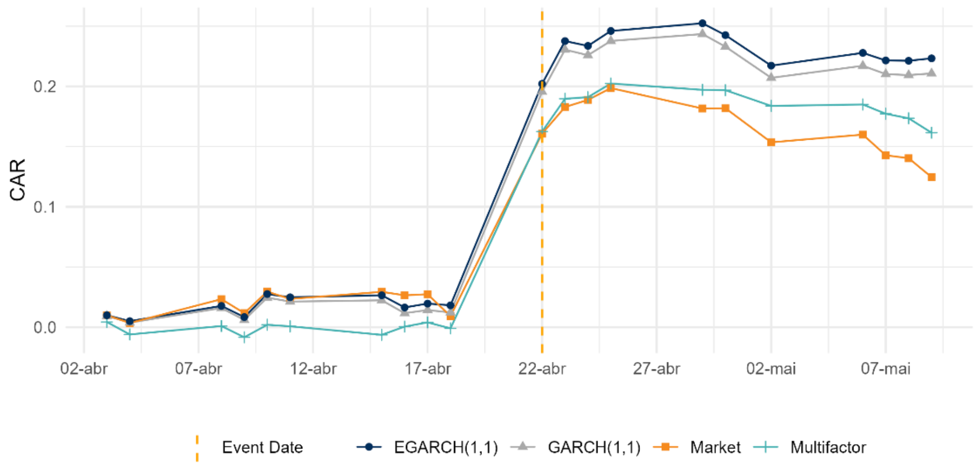


Figure 4.3: Cumulative Abnormal Returns for the event window (-10, +10) Source: Own elaboration

In the (-1, +1) interval, CARs range from +15.5% (MM) to +21.8% (EGARCH), suggesting that a major part of the price reaction took place in the neighborhood of the announcement over the three days. For a broader perspective across different event windows, refer to Appendices Appendix P Appendix Q, and Appendix R, for the underlying data tables supporting the cumulative return analysis refer to Appendices Appendix S - Appendix Y.

Moving to the horizon of (-3, +3), CARs reach as high as +21.3% for GARCH and +22.1% for EGARCH, with the MM having the lower values, peaking at +15.2%. This would imply the market reaction was not confined to a single day but localized over a narrow period. In the horizon of (-5, +5), the CARs settle down to a range within +21.7% for EGARCH and +16.7% for the MM, while in the interval of (-10, +10), the CARs plateau around +23.3% (GARCH) and +24.6% (EGARCH), suggesting no significant reversal taking place.

In short, the event produced a persistent upward shift in the equity value of Galp, with ARs exceeding 20%, unaffected by the choice between models or wider market revisions. Market reaction was rapid, concentrated, and economically large.

4.2. Statistical Significance of Results

4.2.1. Parametric Tests

The parametric tests present strong evidence that the news announcement regarding the oil discovery by Galp is connected with statistically significant ARs.

Table 4.1: Parametric test results for event window (-1, +1)

Model	AR_t0	t_AR_t0	mean_AR	t_mean_AR	CAR	t_CAR
Market	0.1513	9.9947	0.0515	5.8965	0.1546	5.8965
Multifactor	0.1635	14.1847	0.0619	9.3047	0.1858	9.3047

GARCH	0.1831	12.0962	0.0718	8.2134	0.2153	8.2134
EGARCH	0.1838	12.1477	0.0725	8.3025	0.2176	8.3025

Source: Own elaboration

As displayed in Table 4.1 (where t_AR_t0 is the t-statistic for the AR on the event day, t_mean_AR represent the t-statistic of the AAR across the event window, and t_CAR are the CAR's t-statistics), at the defined event day (t0), the AR has an exceptionally high statistical significance through all the analytical models used. The t-statistics range between 9.99 using the MM to 14.18 using the Multifactor Market Model, unequivocally crossing over traditional significance levels (1%, 5%). This statistical analysis proves that the huge price correction seen on April 22, 2024, is not likely to originate from mere random movements. Parametric tests results for other event windows are displayed in appendices Appendix Z, Appendix AA, and Appendix BB.

For the CARs, the statistical significance also remains high for short- to medium-term horizons. In the (−1, +1) interval, the CAR t-statistics are greater than 5.9 for the MM and 9.3 for the Multifactor Market Model, so most of the adjustments are statistically significantly non-zero. In longer horizons, for instance, (−3, +3), (−5, +5), the CARs are positive and statistically significant with t-values always greater than 3.0 across GARCH-type models. For the (-10, +10) interval, findings are less robust. CARs are still positive and economically substantial (up to +22.3% for EGARCH), but statistical relevance is diluted in the MM ($t = 1.79$) and only achieves traditional critical values for GARCH ($t \approx 3.0 - 3.2$) and EGARCH ($t \approx 3.2 - 3.3$) models. This means that the best statistical evidence points to the immediate and near-term adjustment, with longer horizons capturing additional volatility but also extraneous market activity.

Together, the parametric results provide strong evidence suggesting that the April 22 positive revaluation was not just a statistical fluke but instead a repeat market response to the announcement.

4.2.2. Non-Parametric and Robustness Checks

Table 4.2: Non-parametric test results for event window (-10, +10)

Model	z_sign	pval_sign	p_boot_AR0	p_boot_CAR
Market	0,2182	0,8273	0,048	0,514
Multifactor	-0,2182	0,8273	0,051	0,434
GARCH	0,2182	0,8273	0,057	0,455
EGARCH	0,2182	0,8273	0,054	0,464

Source: Own elaboration

The generalized sign test reveals inconclusive results as seen in Table 4.2. The proportion of positive-to-negative returns in the vicinity of the event is not significantly different from a pure random distribution, as indicated by z-scores close to zero (between -0.22 and 0.22) and by p-values around 0.82. This also means that, even though the response size is large, the direction-based tendency across the daily returns is less systematic, as is in line with the evidence that the adjustment was concentrated in a small number of trading days. Nonparametric tests results for other event windows are displayed in appendices Appendix CC, Appendix DD, and Appendix EE.

Bootstrap tests provide additional robustness. Under resampling, the probability of observing an AR as extreme as that of the event day is low (e.g., $p \approx 0.048$ under the MM), reinforcing the exceptional nature of the April 22 return. In contrast, bootstrapped p-values for CARs (e.g., 0.43 to 0.62) are higher, indicating that cumulative patterns beyond the immediate announcement window are more difficult to distinguish from chance.

Lastly, parametric tests present robust statistical evidence for the announcement day ARs as well as for the days surrounding the announcement, but the non-parametric and bootstrap procedures indicate the conservative interpretation that the effect was strong, but short-lived, and localized instead of pervasive throughout the entire event period.

This mixed pattern with strong event-day effects and weaker systematic evidence on longer windows leaves the door open for the following discussion in Section 4.3. Specifically, the results raise issues on the extent of price adjustment speed (efficiency), potential short-term continuation, or correction (over/underreaction), as well as whether pre-event patterns represent informed trading.

4.3. Summary of Findings and Limitations

4.3.1. Magnitude of the Response

The findings reveal an exceptionally high and positive price response to the news release on the event of oil discovery in Namibia. In all the models considered, the event day AR ranges between +15% and +18% and is significantly larger relative to the normal stock price responses reported for company-specific news announcements like earnings or mergers and acquisitions announcements.

CARs also verify this result. In the (-1, +1) window, the cumulative gains lie between +15.5% (MM) and +21.8% (EGARCH), the (-3, +3) window provides similar results (+15% to +22%). In the (-5, +5) window, the CARs are always highly positive with +16.7% for the MM and over +21% for GARCH/EGARCH, with parametric tests establishing the respective evidence of significance at standard values. Only for the (-10, +10) window the findings turn somewhat model-sensitive: whereas the CARs are still economically sizable (+22-24%), statistical evidence fades away for the MM ($t \approx 1.8$) but holds in GARCH-type models ($t \approx 3.0 - 3.2$).

From the economic perspective, this magnitude suggests that investors saw the announcement as a major change in Galp's future long-term cash flows. However, the increasingly lower relevance over longer horizons reflects the effect of market changes and simultaneous news effects.

4.3.2. Reaction Time

The revaluation was quick and concentrated. Event-day AR was responsible for a major part of the revaluation, with parametric tests also supporting its high level of significance. Small but positive ARs on the following day (+2% to +3%) suggest limited continuation rather than eventual adjustment.

The days during the event horizon do not exhibit an orderly sequence of ARs. April 18, 2024's negative ARs (-0.18% to -2.3%) are similar across models, thus defeating the argument for major information leakage. However, due to the volatility-prone nature of oil markets by reason of rumors, the possibility cannot be discounted completely.

In summary, the evidence is consistent with the proposition of an information market that incorporated the news quickly and significantly on the initial day of trading.

4.3.3. Evidence of Overreaction or Underreaction

Although the early increase is unequivocal, the long-term durability of these gains puts in doubt the quality of the adjustment process. There are three key points to observe:

1. There is no reversal for the prompt: CARs hold positive values in the horizon (-10, +10), registering no significant correction, hence defeating the argument for the traditional “overreaction” (prices increase above equilibrium and subsequently decrease) within the event windows used on this paper.
2. Moderate continuation: On the post event trading day (April 23), there are additional positive ARs, but less extreme than on determined event day. This would suggest a weak type of underreaction, where not all investors updated their expectations at once.
3. Statistical robustness: Non-parametric tests reveal weaker significance for the CARs, in line with an adjustment sharp but not widely diffused over several days. This is in line

with the hypotheses for a concentrated price shock rather than for a slow, multi-day repricing.

Together, the evidence points towards the direction of quick and successful adaptation but not towards the uniform behavior of over or under-reaction. However, the slight persistence found after the event, combined with the absence of reversal, opens up different possibilities for interpretation on behavioral finance grounds, where heterogeneous beliefs and investor inertia can give rise to transitory departures.

4.3.4. Limitations

There are some identified constraints on these results. First, event studies rely on the proper specification of the expected returns. Even though the results proved robust for the Market, Multifactor, as well as GARCH-type models, the actual magnitude of the ARs still remains model-sensitive. Second, the analysis assumes an individual, one-time event; announcements involving oil often, however, interact with larger macroeconomic and geopolitical trends, possibly contaminating event windows. Thirdly, statistical significance fades over longer horizons, suggesting that aggregate results beyond three to five days need to be interpreted with caution. Finally, though for the most part there is little strong evidence for information leakage, the possibility for insider information or selective rumor distribution cannot be totally eliminated, particularly for industries tied to commodities.

CHAPTER 5

5. Discussion

5.1. Interpretation in Light of EMH

The evidence presented in Chapter 4 shows that stock prices for Galp registered a significant and positive response to the announcement of the discovery. The ARs were clustered around the event-date. This behavior conforms to the concept behind the EMH, specifically the semi-strong form. Galp's rapid and significant response to the announcement of the discovery of oil on April 21, 2024, represents the perfect example of the concept operating.

The large and statistically significant size of the ARs on the event day (greater than +15%) signifies that the market rapidly absorbed the new information and adjusted the valuation of Galp to the future expected cash flows. The price did not remain at a mistakenly evaluated level. Instead, it saw a rapid and immediate adjustment.

The pre-event analysis of ARs strengthens the EMH case. The lack of any systematic, positive directional trend in the days preceding the announcement means that there seems to be no significant information leakage. If rumors or insider trading were widespread, then there should be a gradual pre-announcement price rise prior to the formal announcement. However, the price change was small and non-directional, followed by a large, one-day adjustment that came only after the formal announcement. However, the pre-announcement period exhibits weak but non-systematic ARs thus leaving room for sporadic information leakage or pre-announcement speculative trading.

The examination of CARs further substantiates the notion of a market that is either efficient or at the very least, markedly effective. The CARs observed in the immediate post-event interval (-1, +1) account for the majority of the price adjustment, and these gains seem to remain stable over extended periods without experiencing a significant reversal. The lack of a "reversion to the mean" phenomenon challenges the hypothesis of market overreaction, which posits that prices exceed their equilibrium values before adjusting downwards. The results derived from bootstrapping imply that the cumulative data across longer time frames is less reliable. This suggests that while the market response was rapid, it was not evenly distributed throughout all trading days, prompting considerations regarding temporary inefficiencies or noise trading.

Despite the results' support for the perspective that Galp's adjustment of prices was efficient, they also underline the potential for slight divergences from ideal informational efficiency, in line with the wider academic discourse surrounding event studies related to resource discoveries.

5.2. Comparison with Previous Literature

The findings of this research complement and, in some cases, exceed the size of event-related price reactions reported in the finance literature. Research on similar corporate events, like earnings announcements, mergers, or stock splits, typically reports ARs in the low single digits or at most at a range of 5-10%. As far as ARs after oil and gas discovery announcements are concerned, research aimed at exploration successes in frontier regions usually finds spikes in equity values that then move into a stabilization period as the market digests uncertainties regarding the commercial viability. The size of Galp's AR on the announcement day exceeds 15%. This value sits on the upper boundary of such findings and underlines the strategic importance of Namibia as a basin rich in promise.

This increased response can be related to the inherent nature of the information in question. The discovery of oil reserves of this magnitude does not merely represent a small change to the corporation's profit growth estimates. Instead, it constitutes a strategic event that essentially shifts the long-term risk-return model of the firm. The response by the market reveals such a definitive change since it represents the discovery of a large new asset that had not been accounted for on the company's balance sheet.

Contrary to other studies reporting gradual drift or overreactions in the weeks following announcements, the Galp returns do not show significant reversals in the event windows studied. This suggests that the initial market evaluation of the discovery value was not only quick but also relatively accurate, at least within the short to medium term. The persistence of the CARs over horizons up to (-10, +10) indicates that the market's initial optimism was not an ephemeral blip but a sustained repricing. This finding supports recent evidence proposing that today's financial markets enjoy quick information diffusion and broad analyst coverage and end up correcting mispricing far better than historically seen.

The lack of systematic ARs over longer windows also means that investors did not reward Galp beyond the immediate disclosure, in line with the view that resource discoveries increase valuation primarily through immediate repricing rather than prolonged speculation.

5.3. Implications for Investors and Policymakers

The research findings hold significant outcomes for different stakeholders in the industry.

For investors, the findings reinforce the importance of event timing. The large ARs were almost exclusively achieved by the owners of Galp shares at the time of the announcement. This suggests that the investors who do not respond immediately to publicly released information enjoy significant disadvantages since the strength of the market quickly reduces the chances of arbitrage or delayed profit. The weak persistence of positive ARs recorded on the following day suggests that other investors needed further time to react, consequently, their returns were enormously reduced. The performance of the investment mainly depends on expectations regarding the exploration outcomes rather than on the activities of trading following the announcement in such situations.

Two conclusions can be drawn for regulators and policymakers. First, the lack of evidence regarding information leakage suggests that Galp's internal controls, along with the existing regulatory framework, were successful in preventing insider trading before the official announcement. Second, the rapid and accurate reaction from the market underlines its capacity to mitigate unfair advantages for a select group of privileged individuals. This highlights the value of continued vigilance of disclosure practices and the need for robust mechanisms for enforcement to preserve investor trust and ensure fair playing fields.

The rapid price adjustment captures the notion that the equity markets effectively process relevant discovery news and serve as a good indicator of the economic value inherent in natural resource finds. For the country, in this case Namibia, this can also serve as an indirect indicator of investor sentiment, perceived business outlook, and potentially drive the discussion on the resource governance, taxation, and local participation.

In sum, the case study of Galp exemplifies the advantages and disadvantages associated with market efficiency in the context of significant exploration announcements. It provides valuable insights for investors who are enthusiastic about exploration risk, as well as for regulators overseeing the capital markets linked to resource management.

Conclusion

The main research question in this dissertation was to examine the stock price reaction of Galp Energia to the publicly announced significant oil discovery in Namibia on the 21st of April 2024. Employing a conventional event study methodology, this research investigated whether the capital markets had efficiently incorporated such new and relevant valuable information. The answers obtained through such a study provide clear and robust answers to the research question.

The findings of this research indicate that the market response to the announcement was remarkably rapid and of a magnitude consistent with the significant nature of the information disclosed. The data revealed an exceptionally elevated positive abnormal return (AR) on the day of the event, surpassing +15% across a variety of analytical models, including the Market Model with and without GARCH or EGARCH effects, and the Multifactor Market Model. This distinctive reaction observed on the event day accounted for a substantial portion of the overall increase in value, suggesting that the market swiftly adjusted the stock's price to account for the potential implications of the discovery. The cumulative abnormal returns (CARs) attained levels as high as +21.8% within the immediate three-day interval (-1, +1) and stabilized at over +22% for extended timeframes. The statistical relevance of the ARs on the day of the event, characterized by t-statistics, significantly surpassing conventional critical thresholds. This substantiates that the price adjustment was not merely a random occurrence, but a direct and substantial market reaction to the announcement.

The research also revealed no significant evidence of information spillage in the pre-announcement period in support of the semi-strong form of the Efficient Market Hypothesis (EMH). The ARs were not uniformly positive in the pre-announcement period, suggesting that the information did not appear in the share price until it became publicly announced.

Despite the strong evidence, the dissertation admits a few limitations that deserve discussion. First, the analysis assumes that the market reaction was solely in response to the announcement of the discovery. Although it is probable that this represents the major driver of the significant price increment, it is possible that at the same time prevailing market or macroeconomic factors, which were not modeled, may have had an effect on the returns. The second point is that the choice of the right model for estimating expected returns (e.g., Market Model versus GARCH-type models) impacted the exact measurement of the ARs. It should be noted that the overall directional result and the statistical significance remained unchanged uniformly. This highlights the inherent model sensitivity in event studies. Lastly, the long-run post-event performance analysis only extended to a relatively short span of 10 days. At this duration, the statistical significance of CARs has reduced, and it is suggested that for very long periods the announcement impacts become difficult to distinguish from the general movement in the markets.

The outcomes of this thesis possess considerable implications in practical contexts for investors, policymakers, and corporate executives. For investors, the findings highlight the critical role of market efficiency and the inherent difficulties in achieving ARs through publicly accessible information. The prompt and substantial price adjustments indicate that “buy on the news” tactics may be inadequately timed, as the efficiency of the market rapidly diminishes opportunities for arbitrage. For policymakers and regulatory bodies, the research acts as a favorable sign of market integrity, implying that the existing regulatory framework has effectively curtailed extensive insider trading. This reinforces trust in the equity and openness of financial markets. For corporate leaders, the research emphasizes the significant importance of strategic communications regarding announcements. The notable revaluation of Galp's shares illustrates that significant operational updates, particularly those of a transformative character, such as a world-class discovery, need to be meticulously strategized and conveyed to optimize shareholder value.

Suggestions for Further Research

Results obtained in this work open many perspectives for future research.

Future research studies can try to extend the event horizon for a very long duration (e.g., 6 months to 1 year) to understand whether the early price appreciations are sustainable or not and whether there exists a profound over- or underreaction and then a mean reversion. Such research would yield a better perspective on the long-run valuation by the market of the discovery, as suggested in earlier research on event analysis.

Future studies could also carry out a comparable event study examining the share values of Galp's rivals (e.g., Shell, TotalEnergies, Chevron) to determine if the announcement of the discovery had propagated effects, both beneficial and adverse, on their share prices.

From the behavioral finance point of view, qualitative or quantitative analysis can examine the influence of investor sentiment, media reporting and social media reaction in the period just following the announcement. This analysis attempts to understand more about the modest persistence in the positive returns as the potential weak expression of the underreaction in the behavioral finance perspective.

References

ALSALMAN, Z. (2023). Oil price shocks and US unemployment: evidence from disentangling the duration of unemployment spells in the labor market. *Empirical Economics*, [Online], 65, pp. 1245-1275. Available on: https://doi.org/10.1007/s00181-022-02351-0. [viewed between January and March 2025].

AREZKI, R., RAMEY, V.A. and SHENG, L. (2017). News shocks in open economies: evidence from giant oil discoveries. *Quarterly Journal of Economics*, [Online], 132(1), pp. 103-155. Available on: https://doi.org/10.1093/qje/qjw030. [viewed between January and March 2025].

ARMITAGE, S. (1995). Event study methods and evidence on their performance. *Journal of Economic Surveys*, [Online], 9(1), pp. 25-52. Available on: https://doi.org/10.1111/j.1467-6419.1995.tb00109.x. [viewed between January and March 2025].

BARBER, B.M. and LYON, J.D. (1997). Detecting long-run abnormal stock returns: the empirical power and specification of test statistics. Journal of Financial Economics, [Online], 43(3), pp. 341-372. Available on: https://doi.org/10.1016/S0304-405X(96)00890-2. [viewed between January and March 2025].

BARBERIS, N. and THALER, R. (2003). A survey of behavioral finance. *Handbook of the economics of finance*. [Online]. Amsterdam: Elsevier, pp. 1053-1128. Available on: https://doi.org/10.1016/S1574-0102(03)01027-6. [viewed between January and March 2025].

BAYES, T. (1763). An essay towards solving a problem in the doctrine of chances. *Philosophical Transactions of the Royal Society of London*, [Online], 53, pp. 370-418. Available on: https://doi.org/10.1098/rstl.1763.0053. [viewed in June 2025].

BLACK, F. (1976). The pricing of commodity contracts. *Journal of Financial Economics*, [Online], pp. 167-179. Available on: https://doi.org/10.1016/0304-405X(76)90024-6. [viewed between January and March 2025].

BODIE, Z., KANE, A. and MARCUS, A.J. (2005). *Investments*. 6th edn. New York: McGraw-Hill.

BOEHMER, E., MUSUMECI, J. and POULSEN, A.B. (1991). Event-study methodology under conditions of event-induced variance. *Journal of Financial Economics*, [Online], 30(2), pp. 253-272. Available on: https://doi.org/10.1016/0304-405X(91)90032-F. [viewed between January and March 2025].

BOGLE, J.C. (2017). *The little book of common sense investing*. Updated edn. Hoboken, NJ: Wiley.

BOLLERSLEV, T. (1986). Generalized autoregressive conditional heteroskedasticity. *Journal of Econometrics*, [Online], 31(3), pp. 307-327. Available on: https://doi.org/10.1016/0304-4076(86)90063-1. [viewed between January and March 2025].

BREINLICH, H., LEROMAIN, E., NOVY, D., SAMPSON, T. and USMAN, A. (2018). The economic effects of Brexit: Evidence from the stock market. *Fiscal Studies*, 39(4), pp. 581-623. Available at: https://doi.org/10.1111/1475-5890.12175. [viewed between January and March 2025].

BROWN, S.J. and WARNER, J.B. (1980). Measuring security price performance. *Journal of Financial Economics*, [Online], 8(3), pp. 205-258. Available on: https://doi.org/10.1016/0304-405X(80)90002-1. [viewed between January and March 2025].

BROWN, S.J. and WARNER, J.B. (1985). Using daily stock returns: the case of event studies. *Journal of Financial Economics*, [Online], 14(1), pp. 3-31. Available on: https://doi.org/10.1016/0304-405X(85)90042-X. [viewed between January and March 2025].

BUSSE, J.A. and GREEN, T.C. (2002). Market efficiency in real time. *Journal of Financial Economics*, [Online], 65(3), pp. 415-437. Available on: https://doi.org/10.1016/S0304-405X(02)00148-4. [viewed between January and March 2025].

Campbell, J. Y., Lo, A. W. and MacKinlay, A. C. (2010). *The Econometrics of Financial Markets*. Princeton: Princeton University Press.

CORHAY, A. and TOURANI, R.A. (1996). Conditional heteroskedasticity adjusted market model and an event study. *Quarterly Review of Economics and Finance*, [Online], 36(4), pp. 529-538. Available on: http://doi.org/10.1016/S1062-9769(96)90050-2. [viewed between January and March 2025].

CORRADO, C.J. (1989). A nonparametric test for abnormal security-price performance in event studies. *Journal of Financial Economics*, [Online], 23(2), pp. 385-395. Available on: https://doi.org/10.1016/0304-405X(89)90064-0. [viewed between January and March 2025].

CORRADO, C.J. (2011). Event studies: a methodology review. *Accounting and Finance*, [Online], 51(1), pp. 207-234. Available on: https://doi.org/10.1111/j.1467-629X.2010.00375.x. [viewed between January and March 2025].

CORRADO, C.J. and TRUONG, C. (2008). Conducting event studies with Asia-Pacific security market data. *Pacific-Basin Finance Journal*, [Online], 16(5), pp. 493-521. Available on: https://doi.org/10.1016/j.pacfin.2007.10.005. [viewed between January and March 2025].

DOLLEY, J.C. (1933). Characteristics and Procedure of Common Stock Split-Ups. *Harvard Business Review*, 11(3), pp. 316-326.

DYCKMAN, T.R., PHILBRICK, D., and STEPHAN, J. (1984). A comparison of event study methodologies using daily stock returns: a simulation approach. *Journal of Accounting Research*, [Online], 22, pp. 1-30. Available on: https://doi.org/10.2307/2490855. [viewed between January and March 2025].

EASLEY, D., KIEFER, N.M. and O'HARA, M. (2002). Is information risk a determinant of asset returns? *Journal of Finance*, [Online], 57(5), pp. 2185-2221. Available on: https://doi.org/10.1111/1540-6261.00493 . [viewed between January and March 2025].

ELTON, E. J., GRUBER, M. J., BROWN, S. J. and GOETZMANN, W. N. (2014). *Modern Portfolio Theory and Investment Analysis*. 9th edn. Hoboken, NJ: John Wiley & Sons.

EQUIZA-GOÑI, J. (2020). Oil price shocks and stock returns: evidence for the Eurozone. *Energy Economics*, [Online], 86, 104642. Available on: https://doi.org/10.1016/j.eneco.2020.104951. [viewed between January and March 2025].

FAMA, E.F. (1965a). The behavior of stock-market prices. *Journal of Business*, [Online], 38(1), pp. 34-105. Available on: https://doi.org/10.1086/294743 . [viewed between January and March 2025].

FAMA, E.F. (1965b). Random walks in stock market prices. *Financial Analysts Journal*, [Online], 21(5), pp. 55-59. Available on: https://doi.org/10.2469/faj.v21.n5.55. [viewed between January and March 2025].

FAMA, E.F. (1970). Efficient capital markets: a review of theory and empirical work. *Journal of Finance*, [Online], 25(2), pp. 383-417. Available on: https://doi.org/10.1111/j.1540-6261.1970.tb00518.x. [viewed between January and March 2025].

Fama, E.F., (1976). *Foundations of finance: Portfolio decisions and securities prices*. New York: Basic Books.

FAMA, E.F. (1991). Efficient capital markets: II. *Journal of Finance*, [Online], 46(5), pp. 1575-1617. Available on: https://doi.org/10.1111/j.1540-6261.1991.tb04636.x. [viewed between January and March 2025].

FAMA, E.F. (1998). Market efficiency, long-term returns, and behavioral finance. *Journal of Financial Economics*, [Online], 49(3), pp. 283-306. Available on: https://doi.org/10.1016/S0304-405X(98)00026-9. [viewed between January and March 2025].

FAMA, E.F., FISHER, L., JENSEN, M.C. and ROLL, R. (1969). The adjustment of stock prices to new information. *International Economic Review*, [Online], 10(1), pp. 1-21. Available on: https://doi.org/10.2307/2525569. [viewed between January and March 2025].

FINANCIAL TIMES (2024). Namibia oil discovery: Galp's impact. [Online]. Available on: https://www.ft.com/content/ab3d1bbf-7e7f-4abd-840e-cf0a30186c7f . [viewed between December and January 2025].

GALP (2013a). Murombe-1 exploration well results. [Online]. Available on: https://www.galp.com/corp/en/investors/publications-and-announcements/investor-announcements/investor-announcement/id/425/moosehead-1-exploration-well-results. [viewed between December and January 2025].

GALP (2013b). Wingat-1 exploration well results. [Online]. Available on: https://www.galp.com/corp/en/investors/publications-and-announcements/investor-announcements/investor-announcement/id/413/murombe-1-exploration-well-results. [viewed between December and January 2025

GALP (2013c). Moosehead-1 exploration well results. [Online]. Available on: https://www.galp.com/corp/en/investors/publications-and-announcements/investor-announcements/investor-announcement/id/397/wingat-1-exploration-well-results. [viewed between December and January 2025].

GALP (2019). PEL83 final EIA report - executive summary (Dec 2019). [Online]. Available on: https://www.galp.com/corp/Portals/0/Recursos/Sustentabilidade/SharedResources/Documents/Pessoas,%20Ambiente%20e%20Ativos/GALP%20-%20PEL83%20Final%20EIA%20Report%20FINAL%20(Dec%202019)_executive%20summary.pdf. [viewed between December and January 2025].

GALP (2024). Update 5 on Namibia exploration. [Online]. Available on: https://www.galp.com/corp/pt/investidores/publicacoes-e-comunicados/comunicados-investidor/comunicado/id/1529/update-5-on-namibia-exploration. [viewed between December and January 2025].

HADDOCK, D. D. e MACEY, J. R. (1987). Regulation on demand: A private interest model, with an application to insider trading regulation. *Journal of Law and Economics*, [Online], 30, pp. 311. Available on: https://doi.org/10.1086/467139 . [viewed in April 2025]

HENRY, E. 2008. Are investors influenced by how earnings press releases are written?, *Journal of Business Communication,* [Online], 45 (4): 363-407. Available on: https://doi.org/10.1177/0021943608319388. [viewed 9 April 2025].

HOLLER, J. (2014). *Event-Study Methodology and Statistical Significance*. PhD thesis. University of Osnabrück.

JEGADEESH, N. and TITMAN, S. (1993). Returns to buying winners and selling losers: implications for stock market efficiency. *Journal of Finance*, [Online], 48(1), pp. 65-91. Available on: https://doi.org/10.1111/j.1540-6261.1993.tb04702.x. [viewed between January and March 2025].

JENSEN, M.C. (1978). Some anomalous evidence regarding market efficiency. *Journal of Financial Economics*, [Online], 6(2-3), pp. 95-101. Available on: https://doi.org/10.1016/0304-405X(78)90025-9. [viewed between January and March 2025].

JONES, C.M. and KAUL, G. (1996). Oil and the stock markets. *Journal of Finance*, [Online], 51(2), pp. 463-491. Available on: https://doi.org/10.1111/j.1540-6261.1996.tb02691.x. [viewed between January and March 2025].

KARALI, B., YE, S. e RAMIREZ, O. A. 2018. Event study of the crude oil futures market: A mixed event response model. *American Journal of Agricultural Economics*, [Online], 10. Available: https://doi.org/10.1093/ajae/aay089. [viewed between January and March 2025].

KOTHARI, S.P. and WARNER, J.B. (2007). Econometrics of event studies. In: ECKBO, B.E. (ed.) *Handbook of corporate finance: empirical corporate finance*. [Online]. Amsterdam: Elsevier, pp. 3-36. Available on: https://doi.org/10.1016/B978-0-444-53265-7.50015-9. [viewed between January and March 2025].

KILIAN, L. and PARK, C. (2009). The Impact of Oil Price Shocks on the U.S. Stock Market. *International Economic Review*, 50(4), pp. 1267-1287. https://doi.org/10.1111/j.1468-2354.2009.00568.x. [viewed between January and March 2025].

LEINERT, L. (2012). Does the oil price adjust optimally to oil field discoveries? Working Paper 12/169, *Center of Economic Research at ETH Zurich*. [online] Available on: https://doi.org/10.2139/ssrn.2176648. [viewed between January and March 2025].

LO, A.W. (2004). The adaptive markets hypothesis: market efficiency from an evolutionary perspective. J*ournal of Portfolio Management*, [Online], 30(5), pp. 15-29. Available on: https://doi.org/10.3905/jpm.2004.442611. [viewed between January and March 2025].

LO, A. W. (2012). Adaptive Markets and the New World Order (corrected May 2012). *Financial Analysts Journal*, 68(2), pp. 18-29. Available on: http://dx.doi.org/10.2469/faj.v68.n2.6 [viewed between January and March 2025].

LOUGHRAN, T. and RITTER, J.R. (1995). The new issues puzzle. *Journal of Finance*, [Online], 50(1), pp. 23-51. Available on: https://doi.org/10.1111/j.1540-6261.1995.tb05166.x. [viewed between January and March 2025].

MACKINLAY, A.C. (1997). Event studies in economics and finance. *Journal of Economic Literature*, [Online], 35(1), pp. 13-39. Available on: https://www.jstor.org/stable/2729691. [viewed between January and March 2025].

MALKIEL, B.G. (2019). *A random walk down Wall Street*. 12th edn. New York: W.W. Norton.

MATEI, M. (2009). Assessing Volatility Forecasting Models: Why GARCH Models Take the Lead. *Romanian Journal of Economic Forecasting*, 4(4), pp. 42-65.

MCWILLIAMS, A. and SIEGEL, D. (1997). Event studies in management research: theoretical and empirical issues. *Academy of Management Journal*, [Online], 40(3), pp. 626-657. Available on: https://www.jstor.org/stable/257056. [viewed between January and March 2025].

MISUND, B. (2018) Exploration vs. acquisition of oil and gas reserves: Effect on stock returns. *Cogent Economics & Finance*, 6(1), pp. 1-18.

NELSON, D.B. (1991). Conditional heteroskedasticity in asset returns: a new approach. *Econometrica*, [Online], 59(2), pp. 347-370. Available on: https://doi.org/10.2307/2938260. [viewed between January and March 2025].

SACHS, J.D. and WARNER, A.M. (2001). The curse of natural resources. *European Economic Review*, [Online], 45(4-6), pp. 827-838. Available on: https://doi.org/10.1016/S0014-2921(01)00125-8. [viewed between January and March 2025].

SADORSKY, P. (1999). Oil price shocks and stock market activity. *Energy Economics*, [Online], 21(5), pp. 449-469. Available on: https://doi.org/10.1016/S0140-9883(99)00020-1. [viewed between January and March 2025].

SAMUELSON, P.A. (1965). Proof that properly anticipated prices fluctuate randomly. *Industrial Management Review*, [Online], 6(2), pp. 41-49. Available on: https://doi.org/10.2307/3003046. [viewed between January and March 2025].

SCHWERT, G.W. (2003). Anomalies and market efficiency. *Handbook of the economics of finance*. [Online]. Amsterdam: Elsevier, pp. 939-974. Available on: https://doi.org/10.1016/S1574-0102(03)01024-0. [viewed between January and March 2025].

SHILLER, R.J. (2003). From efficient markets theory to behavioral finance. *Journal of Economic Perspectives*, [Online], 17(1), pp. 83-104. Available on: https://doi.org/10.1257/089533003321164967. [viewed between January and March 2025].

SHILLER, R. J. (2005). Behavioral economics and institutional innovation. *The Journal of Economic Perspectives,* [Online], 19(2), pp. 39-60. Available on: https://doi.org/10.1002/j.2325-8012.2005.tb00702.x. [viewed between January and March 2025].

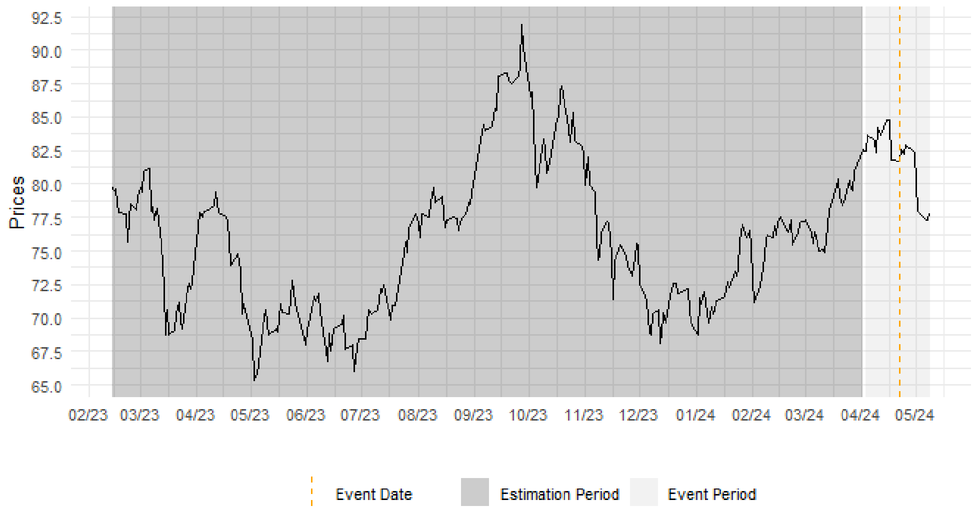
SHILLER, R.J. (2015). *Irrational exuberance*. 3rd edn. Princeton, NJ: Princeton University Press.

SHIVAKUMAR L. 2007. Discussion of Information Uncertainty and Post-Earnings-Announcement-Drift, *Journal of Business Finance and Accounting*, [Online], 34 (3): 434-438. Available on: https://doi.org/10.1111/j.1468-5957.2007.02031.x. [viewed between January and March 2025].

THALER, R.H. (1999). The end of behavioral finance. *Financial Analysts Journal*, [Online], 55(6), pp. 12-17. Available on: https://doi.org/10.2469/faj.v55.n6.2310. [viewed between January and March 2025].

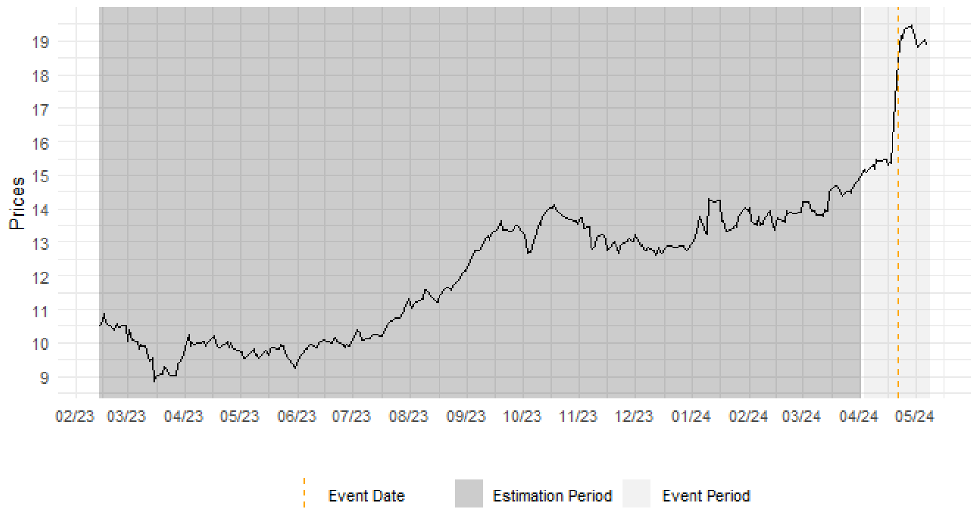
Appendices

Appendix A: Daily closing prices of Brent crude oil from April 2023 to May 2024.



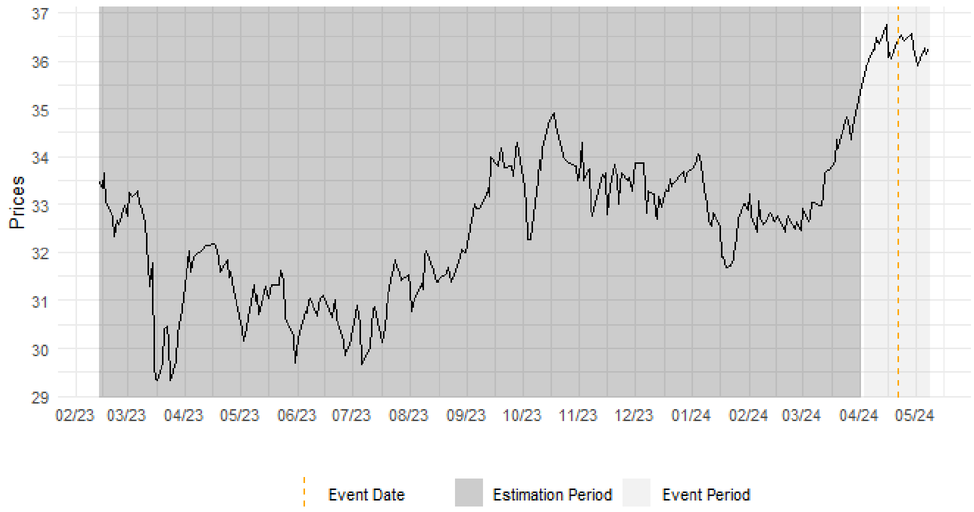
Source: *Own elaboration based on Yahoo Finance data.*

Appendix B: Daily closing prices of Galp Energia from April 2023 to May 2024.



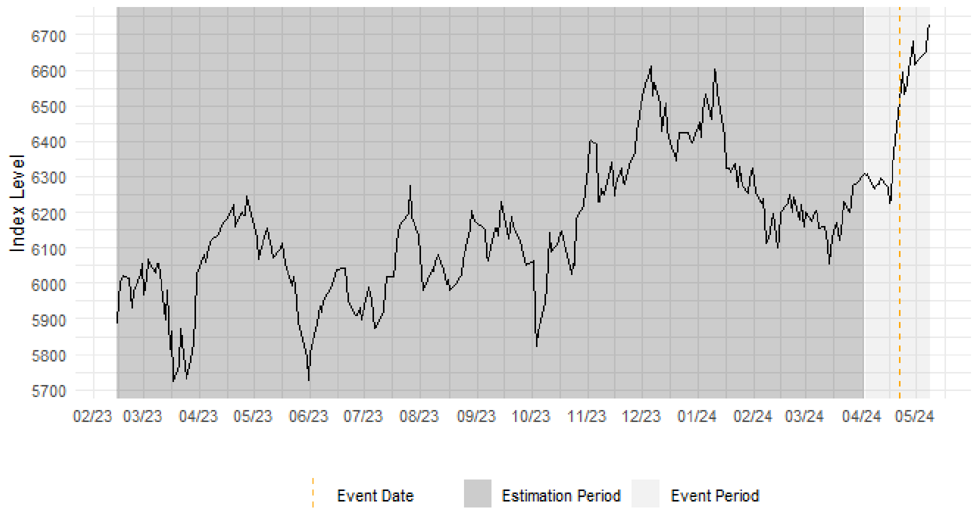
Source: *Own elaboration based on Yahoo Finance data.*

Appendix C: Daily closing prices of STOXX Europe 600 Oil & Gas from April 2023 to May 2024.



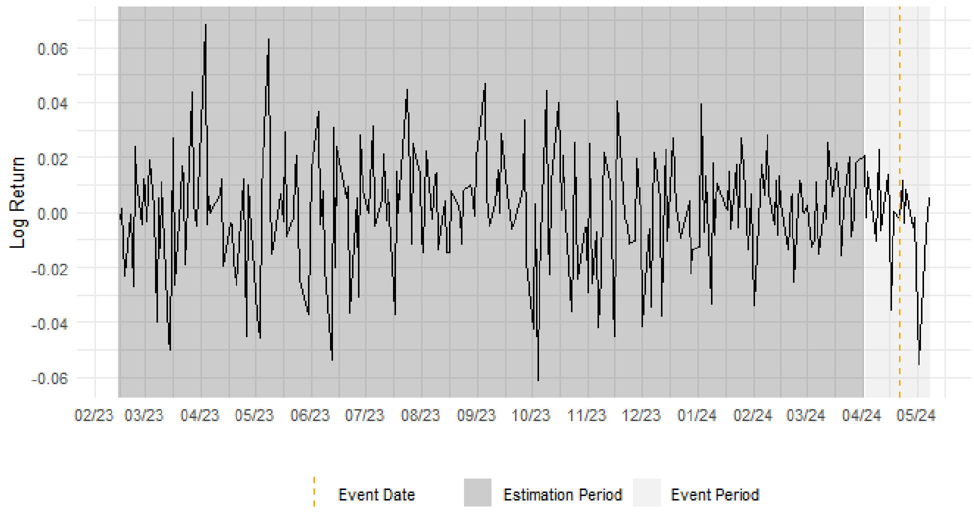
Source: *Own elaboration based on Yahoo Finance data.*

Appendix D: Daily closing levels of PSI from April 2023 to May 2024.



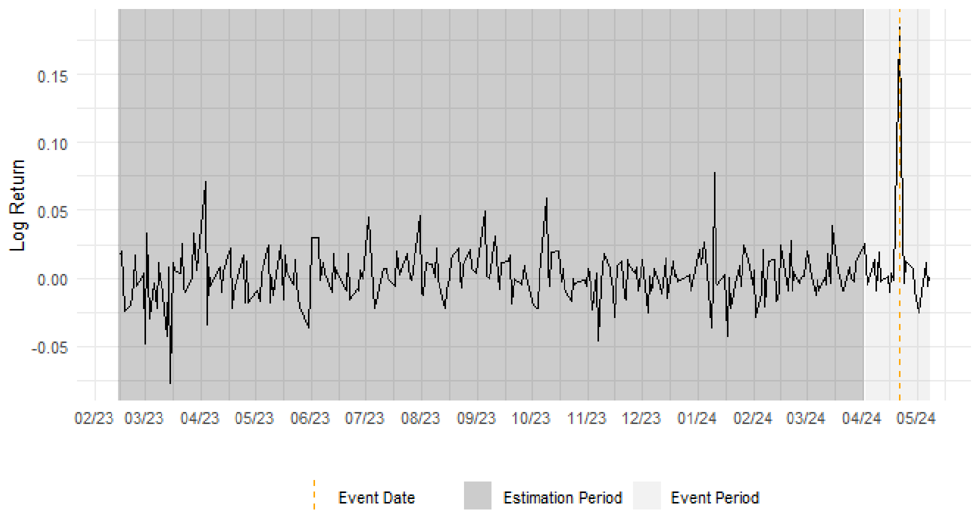
Source: *Own elaboration based on Yahoo Finance data.*

Appendix E: Daily log returns of Brent crude oil from April 2023 to May 2024



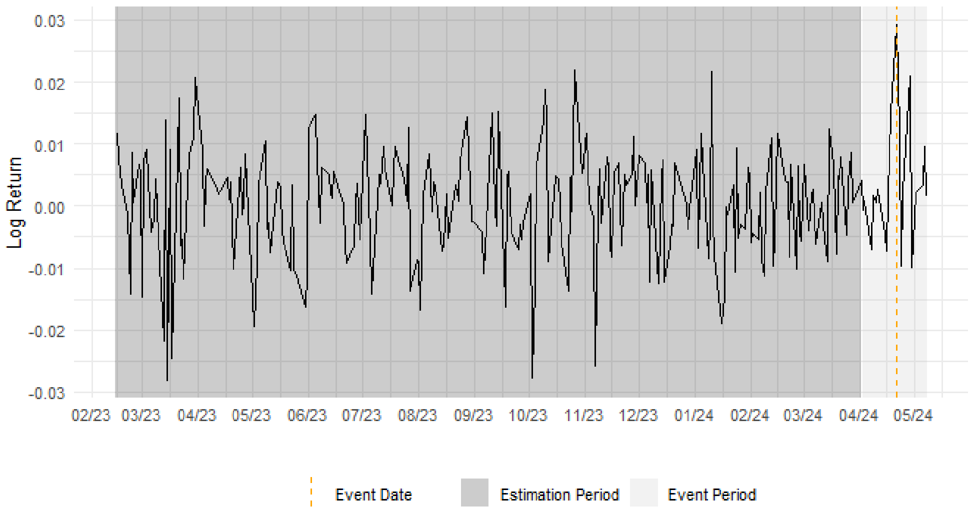
Source: Own elaboration based on Yahoo Finance data.

Appendix F: Daily log returns of Galp Energia from April 2023 to May 2024



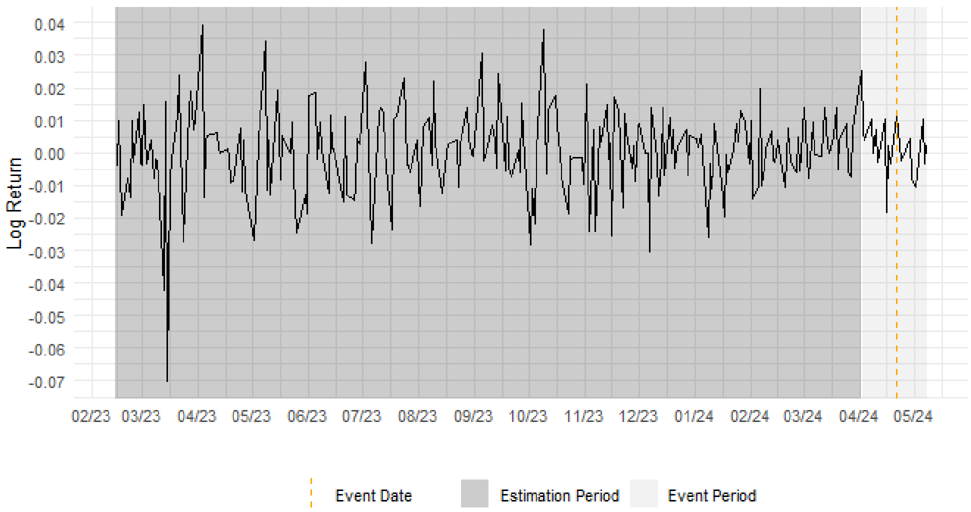
Source: Own elaboration based on Yahoo Finance data.

Appendix G: Daily log returns of PSI from April 2023 to May 2024



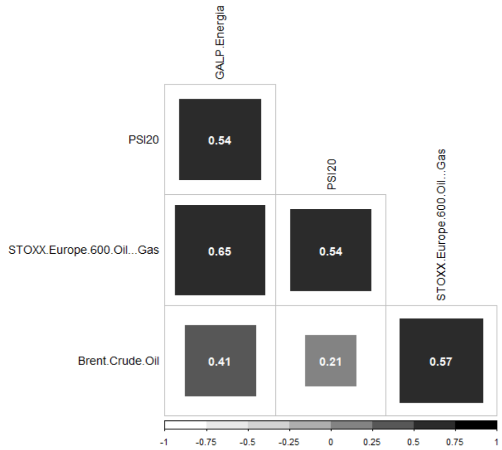
Source: Own elaboration based on Yahoo Finance data

Appendix H: Daily log returns of STOXX Europe 600 Oil & Gas from April 2023 to May 2024.



Source: Own elaboration based on Yahoo Finance data.

Appendix I: Correlation matrix of daily log returns across all assets.



Source: Own elaboration based on Yahoo Finance data.

Appendix J: Jarque-Bera Test results for log-returns

Series	Period	JB-Stat	p-value	Decision
Brent Crude Oil	Estimation	5,1755	0,07519	Borderline Normal
Brent Crude Oil	Event	15,415	0,0004495	Strongly non-normal
GALP Energia	Estimation	120,26	<2,2e-16	Strongly non-normal
GALP Energia	Event	160,9	<2,2e-16	Strongly non-normal
PSI20	Estimation	10,753	0,004625	Mildly non-normal
PSI20	Event	3,9574	0,1382	Normal
STOXX Europe 600 Oil & Gas	Estimation	167,62	<2,2e-16	Strongly non-normal
STOXX Europe 600 Oil & Gas	Event	1,7118	0,4249	Normal

Source: Own elaboration

Appendix K: ADF and KPSS test results for log-returns

Series	ADF-Stat	ADF p-value	KPSS-Stat	KPSS p-value	Decision
Brent	-5,3699	0,01	0,10553	0,1	Stationary
GALP Energia	-5,6619	0,01	0,13292	0,1	Stationary
PSI20	-6,4991	0,01	0,031611	0,1	Stationary
Sectoral Index	5,9957	0,01	0,1492	0,1	Stationary

Source: Own elaboration

For ADF, on the above table p-values are being rounded for display. The true p-values are all below 0.01 and they are different from each other. The function's output only shows p-value = 0.01 as a simplified way of saying "the p-value is statistically significant at the 1% level."

Appendix L: Ljung-Box test results for log-returns

Series	LB-Stat	p-value	Decision
Brent Crude Oil	12,254	0,2684	No autocorrelation
GALP Energia	6,8761	0,7371	No autocorrelation
PSI20	6,7703	0,7469	No autocorrelation
STOXX Europe 600 Oil & Gas	7,3316	0,6938	No autocorrelation

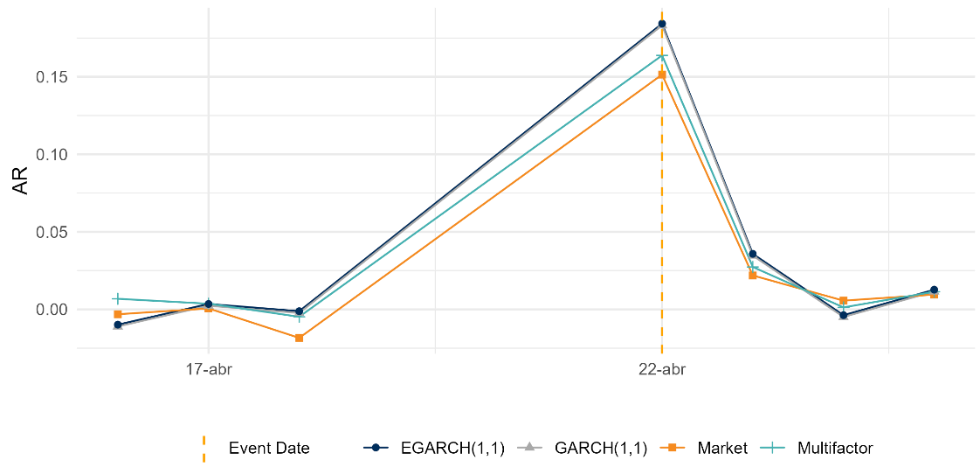
Source: Own elaboration

Appendix M: ARCH-LM test results for log-returns

Series	ARCH-Stat	p-value	Decision
Brent Crude Oil	9,3549	0,4988	No ARCH effects
GALP Energia	5,3355	0,8677	No ARCH effects
PSI20	25,997	0,003744	ARCH effects
STOXX Europe 600 Oil & Gas	11,357	0,3087	No ARCH effects

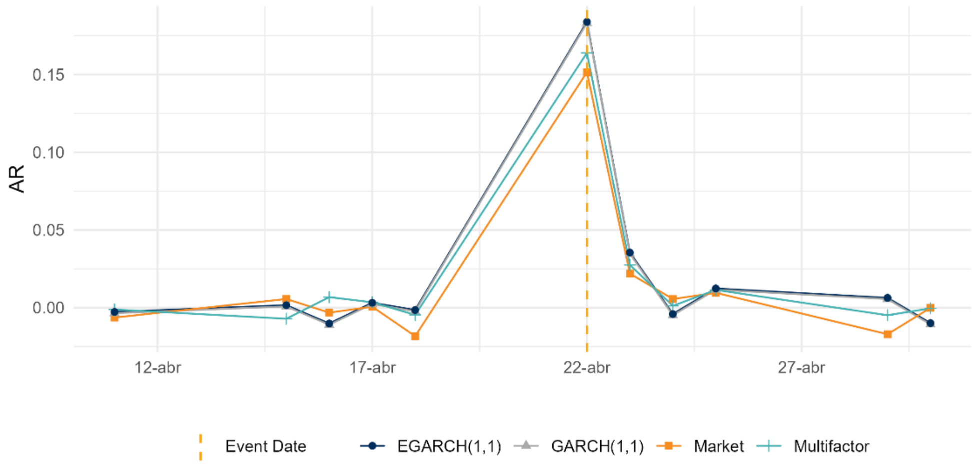
Source: Own elaboration

Appendix N: Abnormal Returns for the event window (-3, +3)



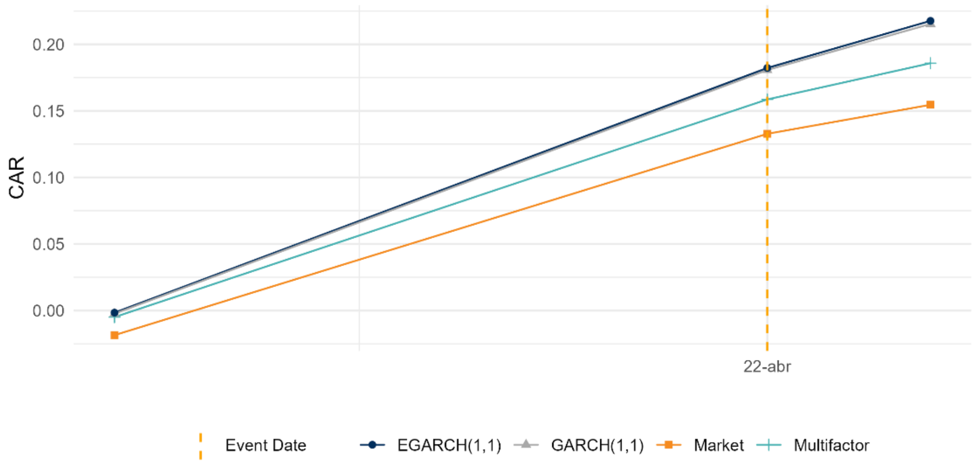
Source: Own elaboration

Appendix O: Abnormal Returns for the event window (-5, +5)



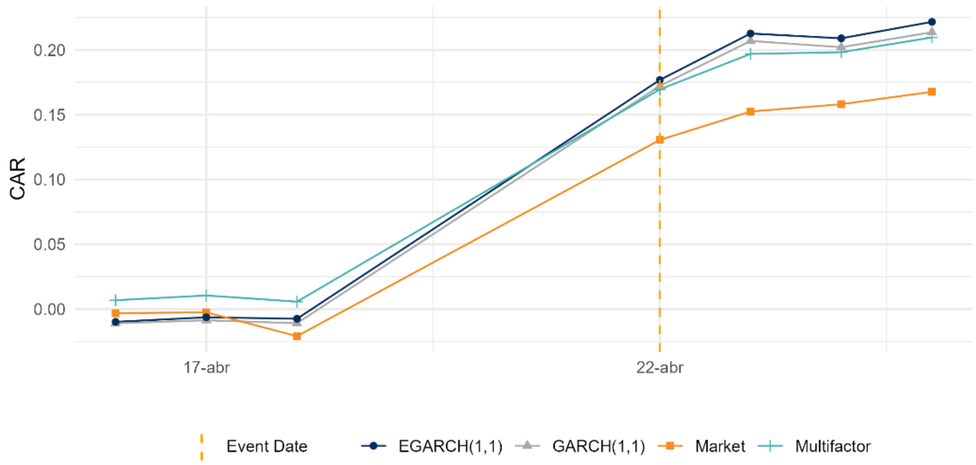
Source: Own elaboration

Appendix P: Cumulative Abnormal Returns for the event window (-1, +1)



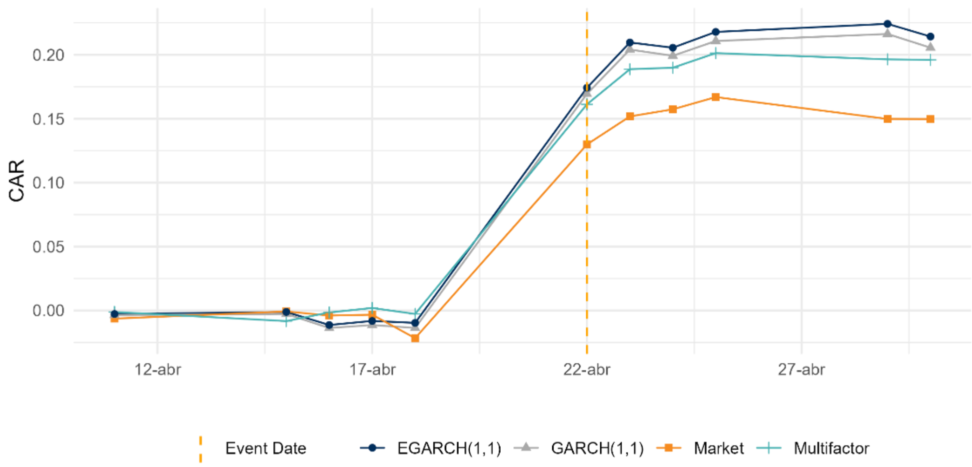
Source: Own elaboration

Appendix Q: Cumulative Abnormal Returns for the event window (-3, +3)



Source: *Own elaboration*

Appendix R: Cumulative Abnormal Returns for the event window (-5, +5)



Source: *Own elaboration*

Appendix S: AR & CAR event window (-1, +1)

Model	Date	Actual	Expected	Abnormal	CAR
EGARCH(1.1)	18/04/2024	-0,00093	0,00066	-0,00159	-0,00159
GARCH(1.1)	18/04/2024	-0,00093	0,00144	-0,00237	-0,00237
Market	18/04/2024	-0,00093	0,01756	-0,01849	-0,01849
Multifactor	18/04/2024	-0,00093	0,00402	-0,00495	-0,00495
EGARCH(1.1)	22/04/2024	0,18449	0,00066	0,18384	0,18225
GARCH(1.1)	22/04/2024	0,18449	0,00144	0,18306	0,18069
Market	22/04/2024	0,18449	0,03324	0,15126	0,13277

Multifactor	22/04/2024	0,18449	0,02096	0,16354	0,15859
EGARCH(1.1)	23/04/2024	0,03604	0,00066	0,03538	0,21763
GARCH(1.1)	23/04/2024	0,03604	0,00144	0,03460	0,21529
Market	23/04/2024	0,03604	0,01424	0,02179	0,15456
Multifactor	23/04/2024	0,03604	0,00882	0,02722	0,18581

Source: Own elaboration

Appendix T: AR & CAR event window (-3, +3)

Model	Date	Actual	Expected	Abnormal	CAR
Multifactor	16/04/2024	-0,00961	-0,01645	0,00683	0,00683
Market	16/04/2024	-0,00961	-0,00648	-0,00313	-0,00313
EGARCH(1.1)	16/04/2024	-0,00961	0,00022	-0,00983	-0,00983
GARCH(1.1)	16/04/2024	-0,00961	0,00136	-0,01098	-0,01098
Multifactor	17/04/2024	0,00373	0,00004	0,00369	0,01052
Market	17/04/2024	0,00373	0,00309	0,00065	-0,00248
EGARCH(1.1)	17/04/2024	0,00373	0,00022	0,00352	-0,00631
GARCH(1.1)	17/04/2024	0,00373	0,00136	0,00237	-0,00861
Multifactor	18/04/2024	-0,00093	0,00382	-0,00475	0,00577
EGARCH(1.1)	18/04/2024	-0,00093	0,00022	-0,00115	-0,00746
GARCH(1.1)	18/04/2024	-0,00093	0,00136	-0,00230	-0,01090
Market	18/04/2024	-0,00093	0,01744	-0,01837	-0,02086
EGARCH(1.1)	22/04/2024	0,18449	0,00022	0,18428	0,17682
GARCH(1.1)	22/04/2024	0,18449	0,00136	0,18313	0,17223
Multifactor	22/04/2024	0,18449	0,02072	0,16377	0,16954
Market	22/04/2024	0,18449	0,03308	0,15141	0,13055
EGARCH(1.1)	23/04/2024	0,03604	0,00022	0,03582	0,21264
GARCH(1.1)	23/04/2024	0,03604	0,00136	0,03467	0,20690
Multifactor	23/04/2024	0,03604	0,00867	0,02736	0,19690
Market	23/04/2024	0,03604	0,01414	0,02190	0,15245
EGARCH(1.1)	24/04/2024	-0,00350	0,00022	-0,00371	0,20893
GARCH(1.1)	24/04/2024	-0,00350	0,00136	-0,00486	0,20204
Multifactor	24/04/2024	-0,00350	-0,00479	0,00130	0,19820
Market	24/04/2024	-0,00350	-0,00913	0,00564	0,15809
EGARCH(1.1)	25/04/2024	0,01292	0,00022	0,01271	0,22164
GARCH(1.1)	25/04/2024	0,01292	0,00136	0,01156	0,21360
Multifactor	25/04/2024	0,01292	0,00152	0,01140	0,20960
Market	25/04/2024	0,01292	0,00334	0,00958	0,16767

Source: Own elaboration

Appendix U: AR & CAR event window (-5, +5) Source: Own elaboration

Model	Date	Actual	Expected	Abnormal	CAR
EGARCH(1,1)	11/04/2024	-0,00216	0,00058	-0,00274	-0,00274
GARCH(1,1)	11/04/2024	-0,00216	0,00137	-0,00353	-0,00353
Market	11/04/2024	-0,00216	0,00419	-0,00635	-0,00635
Multifactor	11/04/2024	-0,00216	-0,00099	-0,00117	-0,00117
EGARCH(1,1)	15/04/2024	0,00216	0,00058	0,00158	-0,00116
GARCH(1,1)	15/04/2024	0,00216	0,00137	0,00079	-0,00274
Market	15/04/2024	0,00216	-0,00343	0,00559	-0,00076
Multifactor	15/04/2024	0,00216	0,00930	-0,00713	-0,00830
EGARCH(1,1)	16/04/2024	-0,00961	0,00058	-0,01019	-0,01135
GARCH(1,1)	16/04/2024	-0,00961	0,00137	-0,01098	-0,01372
Market	16/04/2024	-0,00961	-0,00643	-0,00319	-0,00395
Multifactor	16/04/2024	-0,00961	-0,01639	0,00678	-0,00153
EGARCH(1,1)	17/04/2024	0,00373	0,00058	0,00315	-0,00819
GARCH(1,1)	17/04/2024	0,00373	0,00137	0,00236	-0,01136
Market	17/04/2024	0,00373	0,00310	0,00063	-0,00332
Multifactor	17/04/2024	0,00373	0,00026	0,00348	0,00195
EGARCH(1,1)	18/04/2024	-0,00093	0,00058	-0,00151	-0,00971
GARCH(1,1)	18/04/2024	-0,00093	0,00137	-0,00230	-0,01366
Market	18/04/2024	-0,00093	0,01739	-0,01833	-0,02164
Multifactor	18/04/2024	-0,00093	0,00372	-0,00465	-0,00270
EGARCH(1,1)	22/04/2024	0,18449	0,00058	0,18392	0,17421
GARCH(1,1)	22/04/2024	0,18449	0,00137	0,18312	0,16946
Market	22/04/2024	0,18449	0,03296	0,15153	0,12989
Multifactor	22/04/2024	0,18449	0,02053	0,16396	0,16126
EGARCH(1,1)	23/04/2024	0,03604	0,00058	0,03546	0,20967
GARCH(1,1)	23/04/2024	0,03604	0,00137	0,03467	0,20413
Market	23/04/2024	0,03604	0,01410	0,02193	0,15182
Multifactor	23/04/2024	0,03604	0,00855	0,02749	0,18875
EGARCH(1,1)	24/04/2024	-0,00350	0,00058	-0,00407	0,20559
GARCH(1,1)	24/04/2024	-0,00350	0,00137	-0,00487	0,19926
Market	24/04/2024	-0,00350	-0,00906	0,00557	0,15739
Multifactor	24/04/2024	-0,00350	-0,00466	0,00116	0,18992
EGARCH(1,1)	25/04/2024	0,01292	0,00058	0,01234	0,21794
GARCH(1,1)	25/04/2024	0,01292	0,00137	0,01155	0,21082
Market	25/04/2024	0,01292	0,00336	0,00957	0,16695
Multifactor	25/04/2024	0,01292	0,00149	0,01143	0,20135
EGARCH(1,1)	29/04/2024	0,00689	0,00058	0,00631	0,22425
GARCH(1,1)	29/04/2024	0,00689	0,00137	0,00552	0,21634
Market	29/04/2024	0,00689	0,02397	-0,01708	0,14987
Multifactor	29/04/2024	0,00689	0,01175	-0,00486	0,19648
EGARCH(1,1)	30/04/2024	-0,00936	0,00058	-0,00994	0,21431
GARCH(1,1)	30/04/2024	-0,00936	0,00137	-0,01073	0,20560
Market	30/04/2024	-0,00936	-0,00927	-0,00009	0,14978
Multifactor	30/04/2024	-0,00936	-0,00895	-0,00041	0,19607

Appendix V: ARs & CARs for multifactor market model, event window (-10, +10)

Date	Actual	Expected	Abnormal	CAR
03/04/2024	0,01044	0,00613	0,00431	0,00431
04/04/2024	-0,00442	0,00592	-0,01034	-0,00603
08/04/2024	0,01319	0,00620	0,00699	0,00096
09/04/2024	-0,00877	0,00057	-0,00935	-0,00839
10/04/2024	0,01964	0,00927	0,01037	0,00198
11/04/2024	-0,00216	-0,00092	-0,00124	0,00074
15/04/2024	0,00216	0,00924	-0,00708	-0,00634
16/04/2024	-0,00961	-0,01644	0,00682	0,00048
17/04/2024	0,00373	0,00024	0,00350	0,00398
18/04/2024	-0,00093	0,00401	-0,00494	-0,00096
22/04/2024	0,18449	0,02103	0,16346	0,16250
23/04/2024	0,03604	0,00879	0,02724	0,18974
24/04/2024	-0,00350	-0,00480	0,00131	0,19105
25/04/2024	0,01292	0,00157	0,01135	0,20240
29/04/2024	0,00689	0,01212	-0,00523	0,19717
30/04/2024	-0,00936	-0,00907	-0,00029	0,19688
02/05/2024	-0,02481	-0,01173	-0,01308	0,18380
06/05/2024	0,01110	0,00992	0,00119	0,18499
07/05/2024	-0,00579	0,00191	-0,00770	0,17729
08/05/2024	0,00025	0,00401	-0,00375	0,17353
09/05/2024	0,00252	0,01452	-0,01200	0,16154

Source: Own elaboration

Appendix W: ARs & CARs for EGARCH(1,1), event window (-10, +10)

Date	Actual	Expected	Abnormal	CAR
03/04/2024	0,01044	0,00051	0,00993	0,00993
04/04/2024	-0,00442	0,00051	-0,00493	0,00500
08/04/2024	0,01319	0,00051	0,01268	0,01769
09/04/2024	-0,00877	0,00051	-0,00929	0,00840
10/04/2024	0,01964	0,00051	0,01913	0,02753
11/04/2024	-0,00216	0,00051	-0,00267	0,02485
15/04/2024	0,00216	0,00051	0,00165	0,02650
16/04/2024	-0,00961	0,00051	-0,01012	0,01638
17/04/2024	0,00373	0,00051	0,00322	0,01960
18/04/2024	-0,00093	0,00051	-0,00144	0,01816
22/04/2024	0,18449	0,00051	0,18398	0,20214
23/04/2024	0,03604	0,00051	0,03552	0,23767
24/04/2024	-0,00350	0,00051	-0,00401	0,23366
25/04/2024	0,01292	0,00051	0,01241	0,24608
29/04/2024	0,00689	0,00051	0,00638	0,25246
30/04/2024	-0,00936	0,00051	-0,00987	0,24258
02/05/2024	-0,02481	0,00051	-0,02532	0,21726

06/05/2024	0,01110	0,00051	0,01059	0,22785
07/05/2024	-0,00579	0,00051	-0,00630	0,22156
08/05/2024	0,00025	0,00051	-0,00026	0,22130
09/05/2024	0,00252	0,00051	0,00201	0,22331

Source: Own elaboration

Appendix X: ARs & CARs for GARCH(1,1), event window (-10, +10)

Date	Actual	Expected	Abnormal	CAR
03/04/2024	0,01044	0,00111	0,00933	0,00933
04/04/2024	-0,00442	0,00111	-0,00552	0,00381
08/04/2024	0,01319	0,00111	0,01208	0,01590
09/04/2024	-0,00877	0,00111	-0,00988	0,00602
10/04/2024	0,01964	0,00111	0,01853	0,02455
11/04/2024	-0,00216	0,00111	-0,00327	0,02128
15/04/2024	0,00216	0,00111	0,00106	0,02233
16/04/2024	-0,00961	0,00111	-0,01072	0,01161
17/04/2024	0,00373	0,00111	0,00263	0,01424
18/04/2024	-0,00093	0,00111	-0,00204	0,01220
22/04/2024	0,18449	0,00111	0,18339	0,19559
23/04/2024	0,03604	0,00111	0,03493	0,23052
24/04/2024	-0,00350	0,00111	-0,00460	0,22591
25/04/2024	0,01292	0,00111	0,01182	0,23773
29/04/2024	0,00689	0,00111	0,00578	0,24351
30/04/2024	-0,00936	0,00111	-0,01047	0,23305
02/05/2024	-0,02481	0,00111	-0,02592	0,20713
06/05/2024	0,01110	0,00111	0,01000	0,21713
07/05/2024	-0,00579	0,00111	-0,00689	0,21023
08/05/2024	0,00025	0,00111	-0,00085	0,20938
09/05/2024	0,00252	0,00111	0,00141	0,21079

Source: Own elaboration

Appendix Y: ARs & CARs for market model, event window (-10, +10)

Date	Actual	Expected	Abnormal	CAR
03/04/2024	0,01044	0,00050	0,00994	0,00994
04/04/2024	-0,00442	0,00202	-0,00644	0,00350
08/04/2024	0,01319	-0,00661	0,01980	0,02330
09/04/2024	-0,00877	0,00285	-0,01163	0,01167
10/04/2024	0,01964	0,00174	0,01790	0,02957
11/04/2024	-0,00216	0,00394	-0,00610	0,02346
15/04/2024	0,00216	-0,00373	0,00589	0,02936
16/04/2024	-0,00961	-0,00675	-0,00286	0,02649
17/04/2024	0,00373	0,00285	0,00089	0,02738
18/04/2024	-0,00093	0,01724	-0,01817	0,00921

22/04/2024	0,18449	0,03292	0,15157	0,16078
23/04/2024	0,03604	0,01393	0,02211	0,18289
24/04/2024	-0,00350	-0,00941	0,00591	0,18880
25/04/2024	0,01292	0,00310	0,00982	0,19862
29/04/2024	0,00689	0,02386	-0,01697	0,18165
30/04/2024	-0,00936	-0,00961	0,00025	0,18190
02/05/2024	-0,02481	0,00352	-0,02833	0,15357
06/05/2024	0,01110	0,00469	0,00642	0,15998
07/05/2024	-0,00579	0,01139	-0,01718	0,14281
08/05/2024	0,00025	0,00269	-0,00244	0,14037
09/05/2024	0,00252	0,01826	-0,01574	0,12463

Source: Own elaboration

Appendix Z: Parametric test results for event window (-3, +3)

Model	AR_t0	t_AR_t0	mean_AR	t_mean_AR	CAR	t_CAR
Market	0,1514	9,9981	0,024	4,1846	0,1677	4,1846
Multifactor	0,1638	14,1841	0,0299	6,8611	0,2096	6,8611
GARCH	0,1831	12,0927	0,0305	5,331	0,2136	5,331
EGARCH	0,1843	12,1685	0,0317	5,5317	0,2216	5,5317

Source: Own elaboration

Appendix AA: Parametric test results for event window (-5, +5)

Model	AR_t0	t_AR_t0	mean_AR	t_mean_AR	CAR	t_CAR
Market	0,1515	10,0237	0,0136	2,9873	0,1498	2,9873
Multifactor	0,164	14,1794	0,0178	5,1125	0,1961	5,1125
GARCH	0,1831	12,1137	0,0187	4,1008	0,2056	4,1008
EGARCH	0,1839	12,166	0,0195	4,2744	0,2143	4,2744

Source: Own elaboration

Appendix BB: Parametric test results for event window (-10, +10)

Model	AR_t0	t_AR_t0	mean_AR	t_mean_AR	CAR	t_CAR
Market	0,1516	9,9767	0,0059	1,7901	0,1246	1,7901
Multifactor	0,1635	14,0319	0,0077	3,026	0,1615	3,026
GARCH	0,1834	12,0707	0,01	3,0276	0,2108	3,0276
EGARCH	0,184	12,1099	0,0106	3,2074	0,2233	3,2074

Source: Own elaboration

Appendix CC: Non-parametric test results for event window (-1, +1)

Model	z_sign	pval_sign	p_boot_AR0	p_boot_CAR
Market	0,5774	0,5637	0,336	0,585
Multifactor	0,5774	0,5637	0,343	0,555
GARCH	0,5774	0,5637	0,333	0,622
EGARCH	0,5774	0,5637	0,331	0,617

Source: Own elaboration

Appendix DD: Non-parametric test results for event window (-3, +3)

Model	z_sign	pval_sign	p_boot_AR0	p_boot_CAR
Market	1,1339	0,2568	0,134	0,466
Multifactor	1,8898	0,0588	0,14	0,462
GARCH	0,378	0,7055	0,126	0,449
EGARCH	0,378	0,7055	0,138	0,458

Source: Own elaboration

Appendix EE: Non-parametric test results for event window (-5, +5)

Model	z_sign	pval_sign	p_boot_AR0	p_boot_CAR
Market	0,3015	0,763	0,099	0,467
Multifactor	0,3015	0,763	0,084	0,451
GARCH	0,3015	0,763	0,096	0,456
EGARCH	0,3015	0,763	0,084	0,451

Source: Own elaboration