



INSTITUTO
UNIVERSITÁRIO
DE LISBOA

Effect of Greenwashing on Stock Prices

Elaha Abidi

Master in Finance

Supervisor:

PhD, Joaquim Paulo Viegas Ferreira de Carvalho, Assistant Professor

Iscte – Instituto Universitário de Lisboa

September, 2026

Department of Finance

Effect of Greenwashing on Stock Prices

Elaha Abidi

Master in Finance

Supervisor:

PhD, Joaquim Paulo Viegas Ferreira de Carvalho, Assistant Professor

Iscte – Instituto Universitário de Lisboa

September, 2026

This dissertation is dedicated to my loving family- especially my mother and my supportive husband whose unwavering encouragement, strength, and belief in me made this journey possible. I am also grateful to everyone I have encountered along the way crossed paths with on this journey. Your collective influence and support have shaped my approach and enriched this endeavor

Acknowledgment

First of all, I would like to express my sincere thanks to my supervisor, Professor Paulo Viegas de Carvalho, for his availability, insights and guidance which proved most valuable in completing this work.

Secondly, I would like to thank my colleagues, Maria Arsconsa, Setare association members, my family and my husband for their unconditional support, especially my mother who supported me at every step of my life.

Finally, I would like to thank everyone who directly supported me during this journey in the most needed moments.

Resumo

Nos últimos anos, juntamente com o crescente aumento da consciencialização pública sobre as questões ambientais, muitas empresas têm procurado apresentar-se como comprometidas com o desenvolvimento sustentável. No entanto, em alguns casos, esses esforços têm sido mais promocionais do que práticos e não correspondem ao desempenho real da empresa, fenómeno conhecido como greenwashing.

Este estudo investiga o efeito do greenwashing nos preços das ações, analisando de que forma alegações de práticas ambientais enganosas influenciam o comportamento dos investidores. Focando-se em casos de elevada visibilidade, como Coca-Cola, Delta Airlines, HSBC, Unilever, H&M, entre outros, a investigação aplica a metodologia de estudo de eventos para avaliar os retornos anormais (AR), os retornos anormais acumulados (CAR) e os retornos anormais médios (AAR) em torno das divulgações relacionadas com greenwashing. Os dados serão obtidos a partir de bases de dados financeiras (Bloomberg, Yahoo Finance, Nasdaq), relatórios empresariais e fontes mediáticas.

O estudo pretende determinar se os mercados financeiros penalizam empresas envolvidas em greenwashing e se a gravidade e a origem das alegações explicam diferenças nas reações do mercado acionista. Ao relacionar as divulgações de greenwashing com movimentos de preços no curto prazo, os resultados contribuirão para uma melhor compreensão de como a deturpação ambiental afeta a confiança dos investidores e o valor das empresas. Esta investigação fornece ainda contributos relevantes para decisores políticos e investidores na gestão de riscos associados a fatores ESG.

Palavras-chave: Greenwashing, Mercado de Capitais, Mercado Financeiro, ESG, Preços das Ações, Transparência Ambiental.

Classificação JEL: G14,Q56, G15

Abstract

In recent years, alongside growing public awareness of environmental issues, many companies have sought to present themselves as committed to sustainable development. However, in some cases these efforts have been more promotional than practical, and do not align with the company's actual performance, a phenomenon known as greenwashing.

This study investigates the effect of greenwashing on stock prices, analyzing how allegations of misleading environmental practices influence investor behavior. Focusing on high-profile cases such as Coca-Cola, Delta Airlines, HSBC, Unilever, H&M, and others, the research applies the event study methodology to assess abnormal returns (AR), cumulative abnormal returns (CAR), and average abnormal returns (AAR) surrounding greenwashing disclosures. Data will be drawn from financial databases (Bloomberg, Yahoo Finance), company daily reports, and media sources.

The study aims to determine whether financial markets penalize firms engaged in greenwashing, and whether the severity and source of allegations explain differences in stock market reactions. By linking greenwashing disclosures to short-term price movements, the findings will contribute to understanding how environmental misrepresentation affects investor trust and firm value. This research also provides insights for policymakers and investors in managing ESG-related risks.

Keywords: Greenwashing, Capital Market, Financial Market, ESG, stock prices, environmental transparency.

JEL Classification: G14, Q56, G15

List of Abbreviations

ESG - Environmental, Social, and Governance

HSBC - Hongkong and Shanghai Banking Corporation

AR - Abnormal returns

CAR - Cumulative abnormal returns

CAAR - Cumulative Average Abnormal Returns

AAR - Average abnormal returns

EMH - Efficient Market Hypothesis

OLS - Ordinary Least Square

S&P 500 - Standard & Poor's 500

RDS.A/B - Royal Dutch Shell Class A Shares/ B Shares

SBUX - Starbucks Corporation

HSBC - Hongkong and Shanghai Banking Corporation

LuLu - Lululemon

ULVR - Unilever

Ko - Coca-Cola

DAL - Delta Airlines

H&M - Hennes & Mauritz AB

TTE - TotalEnergies

RYAAY - Ryanair

BP - British Petroleum

VOW3.DE - Volkswagen

Index

Acknowledgment.....	i
Resumo	ii
Abstract.....	iii
List of Abbreviations	v
Index	vii
List of Figures.....	ix
List of Tables	xi
Chapter 1.....	1
Introduction.....	1
Chapter 2.....	3
Literature Review	3
2.1 Understanding greenwashing.....	3
2.2 Theoretical Background.....	4
2.2.1 EMH Key Points.....	5
2.2.2 Forms of the Efficient Market Hypothesis	5
2.3 Empirical Evidence for the Efficient Market Hypothesis.....	6
2.4 Information Asymmetry Theory.....	7
2.5 Signaling Theory	8
2.6 Event Study Methodology in ESG Research.....	10
2.7 Gaps in the Literature	12
Chapter 3.....	15
Methodology.....	15
3.1 Research Method Overview	15

3.3 Context of Study	18
3.4 Event Window and Estimation Window	19
3.5 Market Model and Stock Returns	22
3.6 Objective of methodology	24
Chapter 4.....	27
Data Analysis and Results	27
4.1 Global analysis.....	27
4.2 The procedure used for the Event Study of RDS.A stock during the first year	35
Chapter 5.....	41
Conclusion and Limitations.....	41
References.....	43
Annexes	45
Annex A – Expected Returns (2015 - 2025)	45
Annex B – Abnormal Returns (AR)	49
Annex C - Standardized Abnormal Returns (SAR).....	51
Annex D – AAR, CAR, and Statistical Test Results.....	53

List of Figures

Figure 1 - Three efficient market hypotheses	6
Figure 2 - Information Asymmetry.....	7
Figure 3 - Event study Methodology timeline.....	17
Figure 4 - Abnormal Return Graph	20
Figure 5 - Average Abnormal Return.....	21
Figure 6 - Commutative Abnormal Returns	21
Figure 7 - Excess returns of 14 stocks from 2015 to 2019	28
Figure 8 - Excess returns of 14 stocks from 2020 to 2021	29
Figure 9 - Excess returns of 14 stocks from 2022 to 2023	31
Figure 10 - Excess returns of 14 stocks from 2024 to 2025	32
Figure 11 - The timeline of the eight event studies	34
Figure 12 - The result of RDS.A OLS estimation	36

List of Tables

Table 1 - Data source for stock prices	18
Table 2 - Statistical test for BP and Volkswagen	28
Table 3 – Significance	28
Table 4 - Statistical test for Total Energies and Ryanair	30
Table 5 - Significance	30
Table 6 - Statistical tests for Unilever, Coca-Cola, and Delta Airlines	31
Table 7 - Significance	31
Table 8 - Statistical Tests for Lululemon, ExxonMobil, HSBC, Starbucks, Shell.....	33
Table 9 - Significance	33
Table 10 - The result of RDS.A OLS estimation.....	36
Table 11 - The covariance matrix of 7 companies for eight years	37
Table 12 - Expected Return	45
Table 13 - Abnormal Return.....	48
Table 14 - Standardized Abnormal Returns	50
Table 15 – AASGITR Comparison from 2015 - 2019	52
Table 16 – AASGITR Comparison for 2020-2021	52
Table 17 - AASGITR comparison for 2022 – 2023	53
Table 18 - AASGITR Comparison for 2024 – 2025	54

Chapter 1

Introduction

Over the past few decades, environmental sustainability has shifted from a minor concern to a key focus in business strategy and financial decisions. Climate change, plastic pollution, and resource depletion are no longer discussed only in scientific or political arenas; they increasingly shape consumer preferences, regulatory frameworks, and investor expectations. As a result, companies across industries have integrated environmental language into their corporate communications, sustainability reports, and marketing campaigns.

The rapid increase of sustainability-oriented investing has reinforced this trend both institutional and individual investors now consider environmental performance when determining fund allocation and companies acknowledge that their environmental reputation can significantly influence their ability to secure financing and their market value in this context effectively communicating sustainability credentials has become a strategic priority however the drive to project an environmentally responsible image has also created incentives for exaggeration or selective disclosure this is where the concept of greenwashing becomes particularly relevant rather than indicating genuine environmental progress some sustainability claims may inflate accomplishments omit negative details or employ vague language while such tactics might initially enhance a company's reputation they pose considerable risks if accusations of misleading environmental practices arise they can undermine stakeholder trust and cast doubt on the credibility of management.

From a financial perspective, these reputational shocks may translate into measurable market reactions. Investors increasingly interpret environmental transparency as an indicator of long-term risk management and corporate quality. Therefore, disclosures of greenwashing can alter expectations about future cash flows, regulatory exposure, and litigation risk in efficient markets, and new information should be rapidly incorporated into stock prices.

Despite the growing public debate surrounding greenwashing, its short-term impact on stock prices remains an empirical question. Do financial markets penalize firms when greenwashing allegations arise? Investors can distinguish between minor controversies and severe reputational breaches, and does the source of disclosure influence the magnitude of the reaction?

Addressing these questions is important not only for academic understanding but also for practical decision-making for managers. It highlights the financial implications of sustainability communication for investors, and it contributes to the assessment of ESG-related risks for

regulators. It provides evidence relevant to policies aimed at improving environmental disclosure standards.

The present study aims to examine the impact of greenwashing disclosures on stock prices and returns, focusing specifically on international companies that, in recent years, have faced negative media and legal reactions due to misleading environmental advertisements or claims. Notable examples include Coca-Cola during the Paris Olympics, Delta Airlines, H&M, HSBC, and Shell.

To assess the financial implications of these disclosures, the research will utilize the event Study Methodology, which enables the analysis of abnormal stock returns within a defined period before and after the release of greenwashing-related news.

This project answers the following questions:

1. To what extent do public greenwashing allegations influence investor behavior in both short-term and medium-term stock performance across different industries?
2. Can the severity and source of greenwashing claim explain differences in market reactions and abnormal Returns?

The present Master's dissertation is organized into five main chapters. The first chapter introduces the research topics and outlines the background of the study, including the research problem, objectives, and the key research questions, along with an overview of the thesis structure. The second chapter provides a comprehensive literature review, covering the concept of greenwashing, the theoretical framework, existing empirical evidence on market reactions to greenwashing and its impact on stock prices, as well as the application of event study methodology in ESG research, and identifies gaps in the literature. The third chapter explains the methodology adopted in this study, including an overview of the research approach, the event study methodology, the context of the study, the definition of event and estimation windows, the market model used to estimate expected returns, and the objective of the methodology. The fourth chapter presents the data analysis and interpretation of the results. Finally, the fifth chapter summarizes the conclusion and limitations of the research.

Chapter 2

Literature Review

2.1 Understanding greenwashing

Greenwashing refers to the practice of companies presenting a false or exaggerated image of their environmental performance. The first term was coined by environmentalist Jay Westerveld in 1986, and since then, it has been widely used to describe corporate misrepresentation of sustainability efforts (Lyon & Montgomery, 2015a). The website stopgreenwashing.org, organized by Greenpeace, began with saying “Every day, Americans are bombarded with advertising about environmentally friendly goods and services. But how many really are green, and how many are just pretending?” and also added that the greenwash is “used to describe the act of misleading consumers regarding the environmental practices of the company or the environmental benefits of a product or services Lyon & Montgomery (2015b, P. 225)”. From a strategic perspective, green washing can be understood as a form of information asymmetry, where companies possess more information about their true environmental impact than investors or consumers. By disclosing selective information, firms attempt to shape perceptions without undertaking meaningful environmental improvements (Terra Choice, 2007). In financial markets, greenwashing is particularly relevant because sustainability performance is increasingly integrated into ESG ratings and investment decisions.

Greenwashing occurs when a company’s environmental claims do not align with its actual environmental performance.

As Environmental, Social, Governance (ESG) investing becomes more popular, greenwashing is increasingly seen as a significant risk to investors and market credibility. In recent years, scholars have also emphasized the reputational risks of greenwashing, pointing out that firms caught in such practices may not only lose investors’ trust but also face consumer backlash, regulatory penalties, and long-term damage to brand equity (Lyon & Montgomery, 2015b).

Greenwashing becomes especially important in the relationship between companies and the natural environment because most stakeholders cannot easily verify how environmentally responsible a firm truly is. Since environmental performance is often complex and not directly observable, people depend on what companies communicate about themselves. Firms therefore signal their environmental commitment through sustainability reports, advertisements, websites, and eco-labels or certifications. This reliance on corporate communication creates a

space where companies may present themselves as more environmentally friendly than they actually are. (Bowen, 2014, p.3) mentioned that, in particular, earlier research on greenwashing generally takes the view that greenwashing is: 1) An information disclosure decision; 2) Deliberated; 3) Initiated by the company; 4) Beneficial for companies and costly to society. Bowen sees greenwash as a specific subset of symbolic corporate environmentalism in which the changes are both 'merely symbolic' and deliberately so.

Because greenwashing is a complex phenomenon, it has several different aspects. One of these is selective disclosure, which happens when companies carefully choose what information to share. They highlight their positive environmental initiatives and achievements, while leaving out or downplaying negative information about their environmental impact. In this way, the company creates a more favorable image without fully revealing its actual environmental performance (Zhang et al., 2022). Decoupling refers to a situation where a company's public claims about sustainability do not match what it actually does in practice. In other words, the organization may promote strong environmental commitments through advertisement, sustainability reports, or public statements, but if its real business operations and internal practices do not reflect those promises, this creates a gap between what the company says and how it truly behaves (Zhang et al., 2022). This narrow conception of greenwashing is useful because it allows enough precision for greenwashing to be empirically modeled and measured.

2.2 Theoretical Background

The effect of greenwashing on stock prices can be understood through the efficient market hypothesis, the theory that tries to explain how financial markets behave and how stock prices are determined. Developed by Fama (1969), the theory argues that security prices always reflect all available information. This means that, at any point in time, stock prices are considered fair and represent the true value of the asset (Logue, n.d.). When economists refer to efficient markets, they mean a market in which investors behave rationally and take all available information into account when making decisions. According to the Efficient Market Hypothesis (EMH), stock prices fully and quickly reflect this information, meaning that securities are fairly valued at any given moment. Under EMH, prices change mainly when new, unexpected information enters the market. Once investors process this new information, prices adjust rapidly, and the market returns to a state of efficiency (Logue, n.d.). According to this theory, it would not be possible for individual investors, traders, or fund managers to consistently outperform the market.

The idea of “beating the market, Bowen, (2014, p.383) ”, earning returns higher than the overall market average, would not make sense because stock prices would already reflect all available information. As a result, there would be no consistently undervalued or overvalued stocks to take advantage of. In its strongest version, the efficient market hypothesis suggests that both fundamental analysis (studying financial statements and company performance) and technical analysis would not help investors achieve superior returns. The only way to earn abnormal profits would be through insider information, which is illegal (Logue, n.d.).

For this reason, EMH is a highly debated theory. While many economists support it, others criticize it, arguing that markets are not always perfectly rational and that inefficiencies do exist

2.2.1 EMH Key Points

- According to the efficient market hypothesis, stock prices incorporate all available information, suggesting that financial analysis does not provide benefits in terms of earning abnormal returns.
- The theory has been proven mostly correct, although anomalies exist.
- Index investing, which is justified by the efficient-market hypothesis, has supported the theory.

2.2.2 Forms of the Efficient Market Hypothesis

According to Logue (n.d.), the Efficient Market Hypothesis (EMH) explains how information is reflected in stock prices and is commonly divided into three forms: weak, semi-strong, and strong Figure 1. The weak form suggests that all past price information is already incorporated into current stock prices, meaning that analyzing historical price trends does not help investors predict future movements or earn abnormal returns. The semi-strong form goes further, stating that all publicly available information, such as financial reports, news, and economic data, is quickly reflected in stock prices. As a result, investors cannot consistently achieve higher returns using publicly available information alone. The strong form represents the most extreme view, arguing that stock prices fully reflect all information, both public and private, including insider knowledge. Under this assumption, no investor can consistently outperform the market, regardless of the information they possess.

Overall, EMH suggests that financial markets are highly efficient, making it difficult for investors to gain an advantage through analysis or access to information.



Figure 1 - Three efficient market hypotheses

2.3 Empirical Evidence for the Efficient Market Hypothesis

The idea that financial markets respond efficiently to information has been explored for many years through practical research rather than theory alone. While some researchers question how efficient markets truly are, a wide range of studies indicate that price movements generally reflect available information without allowing easy opportunities for consistent extra profit.

Some of the earliest research in this area focused on professional fund managers. By examining long-term performance rather than short-term gains, researchers found that investment funds managed by experts rarely performed better than the overall market once costs such as fees were deducted. This suggests that patterns in past prices do not offer a dependable way to predict future returns, which aligns with basic assumptions of market efficiency (Sewell, 2012).

Further research focused on the speed at which financial markets respond to newly disclosed information. When firms publish their earnings figures, share prices usually change within a very short period. This swift movement suggests that the market processes public announcements almost instantly, making it difficult for investors to gain an advantage once the information has been released (Sewell, 2012).

Studies have also looked at whether individuals with access to confidential information hold an advantage, although insiders sometimes appear to earn higher returns, those gains often disappear after adjusting for risk and trading expenses. This indicates that even privileged information does not consistently lead to above-average performance, supporting the view that markets limit the ability to exploit information for profit (Sewell, 2012).

In general, research findings indicate that the Efficient Market Hypothesis applies to many financial markets. Nevertheless, the theory does not explain every market behavior, as some irregularities and patterns challenge its assumptions. For instance, evidence of momentum and value effects suggests that strategies built on historical price trends or fundamental analysis may sometimes deliver higher-than-average returns over extended periods. Moreover, certain investors might achieve superior performance by using specialized trading techniques, such as high-frequency trading, which rely more on speed and technology than on publicly available information.

2.4 Information Asymmetry Theory

Information asymmetry describes a situation in which two parties involved in a deal do not have the same level of knowledge. One side may possess more detailed or accurate information than the other, which can influence the choices they make. If both sides had equal access to all relevant facts, their decisions might be different.

This imbalance is especially common in transactions between buyers and sellers. For instance, the seller may know more about the true condition or quality of a product, while the buyer must rely on limited information. As a result, the transaction may not fully reflect the product's real value Figure 2 (Mohn, 2025).

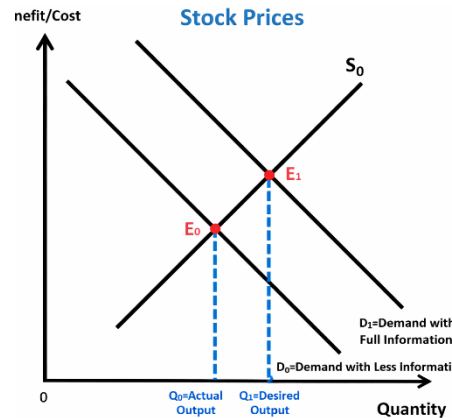


Figure 2 - Information Asymmetry

Interest in information asymmetry grew strongly in the 1970s, when economists began examining how markets function when one side knows more than the other. Researchers such as George Akerlof, Michael Spence, and Joseph Stiglitz played an important role in showing how this imbalance can shape economic behavior and market outcomes. While most economists agree that unequal access to information matters, they do not always agree on how large or harmful its effects are (Akerlof et al., 2001).

To limit potential problems, governments have introduced consumer protection rules designed to make transactions more transparent and fairer. These regulations aim to reduce situations where one party takes advantage of having superior knowledge. Even though information asymmetry can create market distortions, it does not always lead to negative results. In some situations, it can even highlight hidden strengths, such as when a job applicant proves to be more qualified than initially assumed (Akerlof et al., 2001).

The concept of information asymmetry has been extensively developed in literature through the contributions of Akerlof, Spence, and Stiglitz. Akerlof highlighted how differences in information between buyers and sellers can lead to adverse selection, where lower-quality products dominate the market. Building on this, Spence introduced the idea of signaling, explaining how better-informed agents can convey credible information to reduce uncertainty. Completing these perspectives, Stiglitz focused on screening mechanisms, where less-informed parties design strategies to distinguish between different types of agents. Together, these contributions provide a comprehensive framework for understanding how information imbalances shape market outcomes (Akerlof et al., 2001). These theoretical insights are particularly relevant in the context of greenwashing, where firms may strategically disclose or withhold information, creating information asymmetries between companies and investors.

This idea is not limited to markets for goods or financial assets; it also plays an important role in government decision-making, company oversight, and the study of human behavior in economics. It helps explain situations in which one party delegates responsibilities to another but cannot fully monitor their actions because the second party has access to private knowledge.

The same logic can be applied to relations between countries. When governments do not have equal or accurate information about each other's plans, strengths, or intentions, they may make wrong assumptions. These misunderstandings can lead to poor strategic decisions and, in some cases, serious disputes (Akerlof et al., 2001).

2.5 Signaling Theory

The signaling theory suggests that companies voluntarily disclose information to reduce uncertainty and demonstrate quality to investors. Sustainability reports, net-zero commitments, carbon reduction targets, and ESG advertising function as signals of environmental responsibility. Investors interpret these signals as indicators of lower regulatory risk, stronger governance, and long-term stability.

However, if sustainability claims are exaggerated or inconsistent with actual practices, the signal loses credibility. When new information reveals discrepancies, the market may adjust stock prices to reflect the corrected perception of firm value (Hu et al., 2026).

According to Signaling Theory, sustainability announcements by energy firms such as Shell, BP, TotalEnergies, Chevron, and ExxonMobil are intended to reduce information asymmetry and signal long-term adaptation to climate-related risks. If investors perceive these announcements as credible, positive abnormal returns would be expected around the event date. Conversely, if the market interprets such communication as greenwashing, a negative and statistically significant reaction should occur.

One possible interpretation is that the market has already incorporated expectations regarding the sustainability commitments of major oil companies, consistent with semi-strong form market efficiency. Alternatively, investors may perceive sustainability announcements in fossil fuel industries as symbolic rather than value-relevant signals, reducing their impact on stock prices.

Consumer and retail firms such as Starbucks, Lululemon, H&M, Unilever, and Coca-Cola frequently emphasize sustainable sourcing, recycling programs, ethical supply chain management, and environmentally friendly products in their corporate communication. Under Signaling Theory, these disclosures function as signals of responsible management and long-term commitment to sustainability, aiming to reduce information asymmetry and strengthen investor confidence.

If such sustainability claims are later challenged through revelations of labor violations, environmental harm, or misleading green labeling, investors may reassess the credibility of these signals. Signaling Theory predicts that when a signal loses credibility, the market should adjust firm valuation downward to reflect increased reputational and regulatory risk.

For HSBC, sustainability communication includes green bonds, ESG-focused investment products, and climate risk disclosures. Under Signaling Theory, such disclosures are intended to demonstrate responsible capital allocation and long-term risk management. These signals aim to reassure investors that the bank is aligning with global climate standards and reducing exposure to transition risk.

However, if evidence emerges that the bank continues financing high-emission industries while publicly promoting sustainability commitments, the credibility of the signal may weaken. Signaling Theory predicts that when inconsistencies between communication and actual practices become visible, investors may revise their expectations downward, leading to negative abnormal returns.

For Delta Air Lines and Ryanair, sustainability signals typically include carbon offset programs, sustainable aviation fuel initiatives, and emissions reduction targets. Given that

aviation is structurally carbon-intensive, such commitments are subject to strong public and regulatory scrutiny.

Under Signaling Theory, credible environmental commitments should reduce uncertainty regarding future regulatory costs. However, if these claims are perceived as exaggerated or misleading, investors may interpret them as greenwashing, potentially triggering negative abnormal returns.

Although the magnitude of the negative CAAR appears economically noticeable, the absence of statistical significance suggests that the observed effect may be driven by normal market fluctuations rather than event-specific information. The weak market response indicates that sustainability-related signals in the airline industry may lack short-term valuation relevance unless accompanied by regulatory penalties or substantial financial implications.

For Volkswagen, sustainability communication focuses on electric vehicle expansion, emission reduction targets, and transition strategies away from combustion engines. In this sector, environmental credibility is particularly important due to regulatory pressure and past industry scandals.

Signaling Theory suggests that credible environmental commitments should enhance firm value, while contradictions between claims and actual practices may lead to strong market correction due to reputational and legal risks.

Overall, the integration of the Efficient Market Hypothesis, Information Asymmetry Theory, and Signaling Theory provides a comprehensive framework for interpreting the empirical results. While greenwashing allegations theoretically reduce information asymmetry and weaken sustainability signals, the empirical evidence suggests that investors react only when such information is perceived as financial material. The largely insignificant abnormal returns indicate that sustainability-related controversies may not be sufficient to influence short-term stock performance unless accompanied by regulatory enforcement, legal sanctions, or measurable economic consequences. This pattern supports the semi-strong form of market efficiency and suggests that reputational signals alone do not consistently drive valuation adjustments across industries.

2.6 Event Study Methodology in ESG Research

The event study methodology has become one of the dominant empirical approaches for assessing the financial relevance of ESG-related information.

In ESG research, event studies are frequently used to examine market reactions to environmental accidents, regulatory sanctions, sustainability disclosures, ESG rating revisions, and corporate misconduct. Early applications in environmental finance found that negative

environmental events, such as pollution incidents or legal penalties, often generate adverse abnormal returns (Karpoff et al., 2005). These findings support the argument that markets internalize reputational and regulatory risks when they are expected to affect future cash flows.

However, the empirical evidence in ESG research remains mixed. While some studies report significant negative reactions to environmental controversies (Flammer, 2013). Others find weak or insignificant effects, particularly when sustainability information is perceived as symbolic rather than financially material (Aouadi & Marsat, 2018). Friede et al. (2015), conclude that ESG performance is generally associated with favorable financial outcomes. However, they also emphasize that this relationship is not uniform across firms or industries; the strength and direction of the effect vary depending on contextual factors, suggesting that investors do not respond to ESG information automatically; instead, market reactions appear to depend on how financially relevant, credible, and economically significant the sustainability information is perceived to be.

A critical debate in the literature concerns whether event studies adequately capture the economic impact of ESG controversies. One limitation is the assumption of a clearly identifiable event date. In practice, sustainability-related issues often emerge gradually through media coverage, investigations, or activist campaigns. Information leakage before the official announcement may attenuate measured abnormal returns, potentially leading to insignificant findings (McWilliam's & Siegel, 1997). Furthermore, reputational damage may unfold over longer horizons, raising concerns that short event windows underestimate long-term value effects. Another methodological challenge relates to model specifications. The use of the market model or CAPM to estimate expected returns assumes stable risk parameters, which may not hold during periods of heightened controversy. Additionally, ESG-related events may coincide with broader market or industry shocks, complicating causal attribution. Scholars have therefore emphasized robustness checks, alternative estimation windows, and cross-sectional analyses to strengthen inference (Mackinlay, 1997).

From a theoretical standpoint, event studies in ESG research test the intersection of market efficiency, information asymmetry, and signaling theory. If sustainability disclosures function as positive signals of corporate quality, greenwashing allegations should undermine signal credibility and reduce firm value. If such allegations reduce information asymmetry by revealing previously hidden risks, a negative price correction should follow. However, insignificant abnormal returns may suggest that investors either anticipate such risks, discount sustainability claims *ex ante*, or do not perceive reputational controversies as immediately affecting cash flows.

Importantly, recent literature highlights the role of materiality and institutional context. ESG issues that directly affect operational costs, regulatory exposure, or legal liability tend to trigger stronger market reactions than purely reputational concerns (Khan et al., n.d.). This distinction implies that markets differentiate between symbolic sustainability narratives and financially consequential environmental misconduct. Therefore, event study findings must be interpreted not merely as evidence of market indifference, but as an indication that investors condition their reactions on economic relevance.

In the context of greenwashing allegations, the event study methodology provides a rigorous framework to assess whether markets penalize perceived misrepresentation of sustainability practices. Yet, insignificant CAARs do not necessarily imply that greenwashing is inconsequential. Rather, they may reflect the absence of immediate financial penalties, the limited credibility of the source, or prior market anticipation. Consequently, event study results should be interpreted within a broader theoretical framework that accounts for signaling credibility, information asymmetry reduction, and investor expectations regarding future cash flow implications.

Overall, while the event study methodology remains one of the most powerful tools for evaluating the short-term financial impact of ESG-related events, its interpretation requires caution. The methodology captures immediate valuation adjustments but may underestimate delayed reputational or regulatory consequences. Therefore, combining event studies with cross-sectional analysis, industry comparisons, and severity classifications can provide deeper insight into how markets process sustainability-related controversies.

2.7 Gaps in the Literature

Although ESG and sustainability performance have been widely studied in relation to financial outcomes, considerably less attention has been given to the specific market impact of greenwashing allegations. Much of the existing literature examines the long-term relationship between ESG ratings and firm performance, rather than short-term stock market reactions to sustainability controversies. Moreover, greenwashing research has predominantly focused on conceptual discussions, legitimacy theory, and stakeholder perceptions, with limited empirical evidence on whether financial markets penalize firms through abnormal stock returns following greenwashing events. It therefore remains unclear whether investors interpret sustainability communication as credible signals or whether they revise their expectations downward when such communication is perceived as misleading. By applying an event study methodology to greenwashing-related announcements, this study directly tests whether stock prices react

significantly, thereby contributing empirical evidence to the debate on market discipline and information efficiency.

Chapter 3

Methodology

3.1 Research Method Overview

To understand whether greenwashing allegations influence investor behavior, this study uses an event-based analytical approach. Instead of looking at long-term performance, the focus is on what happens to a company's share price immediately after such information becomes public. The idea is simple: if investors consider the allegation important, this should be reflected in changes in the stock price within a short period. By examining price movements around the announcement date and comparing them to normal market behavior, it is possible to identify whether the event triggered an unusual reaction.

The logic behind this method rests on the view that financial markets don't ignore new public information. When relevant news enters the market, investors reassess their expectations about a firm's prospects, and this reassessment is quickly incorporated into share prices. In this context, if a greenwashing allegation changes how investors perceive the company's credibility, risk exposure, or future performance, that shift in perception should become visible through movements in the stock price shortly after the disclosure.

First, the normal behavior of each stock is estimated using data from a period before the event; this helps establish what return would be expected if nothing unusual had happened. The actual returns during the days around the announcement are then compared to this expected level; any difference between the two is considered an abnormal return. By examining these differences over the event window and combining them across firms, it becomes possible to see whether the announcement had a meaningful overall impact (Mackinlay, 1997).

To check whether the price movements are meaningful statistical tests are used to see if the abnormal returns are truly different from zero or simply the result of normal market variation this step helps separate random fluctuations from reactions that may be linked to the announcement if the overall cumulative abnormal return turns out to be negative and statistically significant it would imply that investors responded negatively to the greenwashing allegation however if the result is statistically insignificant it could mean that investors were not strongly influenced by the news either because it had already been expected or because it was not viewed as financially important (Fama et al., 1969).

By applying this methodology across 14 different industries, this study evaluates whether investor reactions vary depending on sector characteristics and the perceived credibility of sustainability communication.

3.2 Event Study Methodology

In this study, the econometric methodology labelled as the event study is described. Researchers are often interested in whether a specific event has influenced company share prices. To examine this, a short-term event study can be applied. Rather than looking at long-term performance, this approach focuses on how stock returns behave in the days surrounding the event. By comparing price movements before the announcement with those observed during the event window, it becomes possible to see whether the event led to any unusual changes in returns. The analysis is based on a statistical test where the null hypothesis assumes that the event did not affect the excess returns of the 14 firms included in this study (Mackinlay, 1996, p. 29-31).

$$H_0 : AR_{it} = 0$$

$$H_1 : AR_{it} \neq 0$$

where H_0 is the null hypothesis, and H_1 is the alternative hypothesis. AR_{it} is the abnormal return of stock i at time t with $T_1 \leq t \leq T_2$, like in the event window.

In the semi-strong interpretation of market efficiency, financial markets are assumed to react quickly when new information becomes public. As soon as this information is released, investors process it and adjust their trading decisions, which causes stock prices to change accordingly. Because of this rapid adjustment, publicly available information is not expected to provide investors with an advantage in predicting future price movements (Fama et al., 1969).

Under this assumption, investors would not be able to consistently achieve higher than normal profits by relying on methods such as fundamental analysis or technical analysis. If an event study detects abnormal or excess returns around a specific event, it could indicate that the semi-strong form of market efficiency does not fully hold in this context. Excess returns refer to the difference between a company's stock return and the benchmark risk-free rate, which is often represented by government securities, such as treasury bills (Fama et al., 1969).

$$\text{Excess return} = R_i - R_f \quad (3.1)$$

The key statistical task in an event study is to identify and calculate abnormal returns. To do this, a model is first used to estimate what the normal or expected return of a stock would be under typical market conditions. After estimating this expected return, it is compared with the actual return observed in the market. The difference between these two values represents the abnormal return, which reflects the potential impact of the event being studied.

The first thing that I do is conduct a timeline of event study, which focuses on the event date ($t=0$). This date marks the moment when new information becomes publicly available, and

if the information is relevant to investors, the market may react immediately, potentially generating abnormal returns. If abnormal returns continue for several days after the event date, this may indicate a potential deviation from the semi-strong form of the Efficient Market Hypothesis. However, when abnormal returns persist beyond the event day, it suggests that the market may not be incorporating the new information immediately. Instead, the adjustment of stock prices occurs gradually, which could reflect delays in how investors interpret or react to the available information. It can also be useful to examine how abnormal returns behave in the days leading up to the event date. If unusual returns appear before day 0, this may suggest that some investors had access to information earlier than the rest of the market. In such situations, it could indicate possible violations of insider trading regulations, where certain market participants act on private information to gain an advantage.

To properly analyze how abnormal returns evolve, researchers use an observation period known as the event window. This window is centered around the date of the event and covers a selected number of days both before and after the event, which I have considered (-3 to +3) days before and after the event date. The results show that the stock returns around the event window fluctuate between positive and negative values. Although some companies experienced small positive returns after the event, others continued to show negative performance; therefore, the greenwashing event does not appear to generate a strong or consistent profit effect across the companies in the sample. By studying this time frame, it becomes possible to observe how the market reacts to new information and how quickly prices adjust.

The second task is to estimate normal returns. An estimation window is defined over a period in which no significant events or unexpected news are assumed to affect the market. This timeframe is used to determine the typical behavior of stock returns under normal market conditions. The typical or average return of a stock during this time provides a baseline that helps assess whether the return observed during the event window is usually high or low. By comparing these values, it becomes possible to determine the presence and significance of abnormal returns for that stock (Bordignon, 2022).

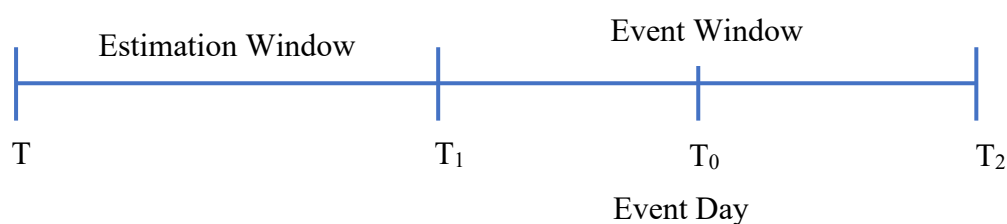


Figure 3 - Event study Methodology timeline

More specifically, T_1 represents the beginning of the event window, T_0 refers to the exact date when the event occurs, T_2 refers to the end of the event window, and T denotes the starting point of the estimation window Figure 3. This estimation period finishes at the moment the event window begins, ensuring that the two periods remain separate and don't overlap.

3.3 Context of Study

The research investigates the impact of greenwashing announcements on stock prices by analyzing a sample of fourteen public companies (Table 1).

Table 1 - Data source for stock prices

Companies	Industry	Event Date	Source of greenwashing News
Shell	Oil & Gas/Energy	2025-01-18	ASA advertising ruling
Starbucks	Food & Beverage/ coffee Retail	2024-10-01	Media reports
HSBC	Banking	2024-06-12	Uk Advertising Standards Authority
ExxonMobile	Oil & Gas/Energy	2024-03-31	Media investigations
Lululemon	Apparel/Retail	2024-02-08	Sustainability investigations
Unilever	Consumer Goods	2023-12-12	NGO reports
Coca-Cola	Beverage	2023-07-09	Environmental NGOs
Delta Airlines	Airline Industry	2023-05-31	Lawsuit / Media reports
H&M	Fashion	2022-07-22	Sustainability label investigation
Total Energies	Oil & Gas/Energy	2021-12-01	NGO complaints
Ryanair	Airline Industry	2020-02-05	UK Advertising Standards Authority
BP	Oil & Gas/Energy	2019-12-04	Environmental NGO reports
Volkswagen	Automotive Industry	2015-09-18	Emissions scandal investigations

These companies are described as having done greenwashing, where companies present themselves as environmentally responsible while their actual practices do not fully support these claims.

The study is conducted within the context of modern financial markets, where environmental, social, and governance (ESG) considerations have become increasingly important for investors.

The greenwashing events analyzed in this study refer to specific dates when information regarding misleading environmental claims became publicly available through media reports, regulatory announcements, or other public disclosures. These events may signal new information on the market and, therefore, can affect the valuation of the companies involved.

Understanding how financial markets react to such events is important for both investors and policymakers. For investors, stock price reactions to greenwashing allegations may provide insights into how environmental credibility affects firm value and investment decisions (Khan et al., n.d.). For regulators and market participants, studying these reactions can help evaluate whether financial markets penalize companies for misleading sustainability claims. By examining the behavior of stock prices around these events, this research aims to determine whether greenwashing announcements lead to abnormal returns for the selected fourteen firms.

3.4 Event Window and Estimation Window

In an event study, two important time periods are defined as the estimation window and event window.

The estimation window is used to calculate the normal or expected return of stock under regular market conditions. This period is selected before the event occurs and is assumed to be free from the influence of the event being studied. Using data from this window, the relationship between the stock return and the market return is estimated to determine expected returns.

The event window represents the time period during which the market reaction to the event is analyzed. It includes several days before and after the event date in order to capture possible information leakage before the event, as well as delayed reactions after the event. The event date is defined as day 0, which corresponds to the first public announcement of the greenwashing allegation related to the company.

In this study, the event window covers a period from -3 days to +3 days around the event date. This allows the analysis to observe stock price movements shortly before and after the announcement. The estimation window is defined as the period before the event window, and it is used to estimate the normal performance of the stocks. To ensure unbiased results, the estimation window does not overlap with the event window (Khotari & Warner, 2006). After estimating the expected returns for each stock, the abnormal return is calculated as the difference between the actual return and the expected return during the event window. The abnormal return measures the impact of the event on stock prices by identifying returns that deviate from normal market behavior. It will be calculated as:

$$AR_{it}=R_{it}-E(R_{it}) \quad (3.2)$$

where R_{it} represents the actual return of stock i on day t , and $E(R_{it})$ represents the expected return estimated from the estimation window (Khotari & Warner, 2006).

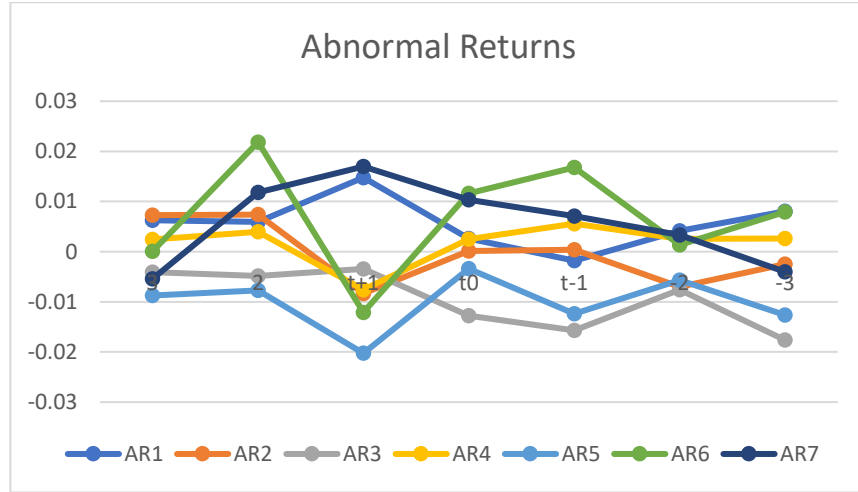


Figure 4 - Abnormal Return Graph

Figure 4 shows that abnormal returns increase after the greenwashing event, although the first observation is negative. This suggests that despite an initial decline, stock returns tend to improve on the days following the event.

To analyze the overall market reaction, abnormal returns are averaged across all the companies. The average abnormal return shows the mean abnormal return for the fourteen firms on each day within the event window.

$$AAR_t = \frac{1}{N} \sum_{i=1}^N AR_{i,t} \quad (3.3)$$

where N is the number of firms in the sample, which is fourteen, the market shows positive abnormal returns at -3 and -2, meaning that investors were optimistic. Only on day -1, AAR becomes negative (-0.00846), suggesting uncertainty or possible information leakage before the event.

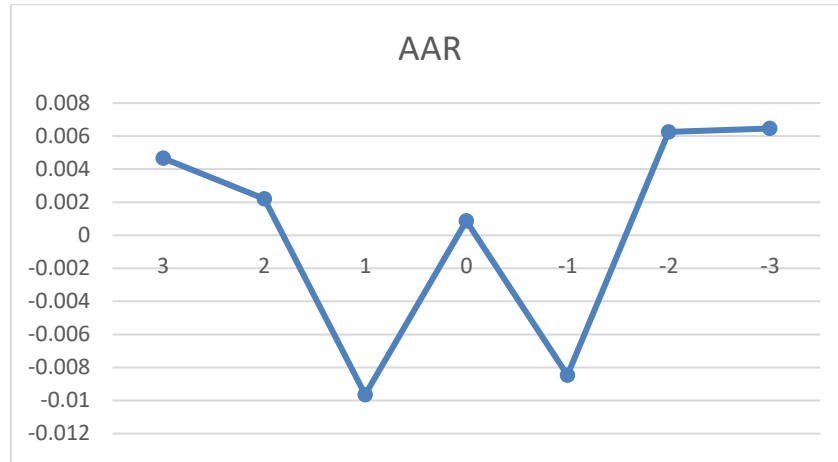


Figure 5 - Average Abnormal Return

This means the immediate reaction to the greenwashing event is very small but positive; investors may initially believe the sustainability claims or that the information has not been fully interpreted yet. After the greenwashing day 1 shows a strong negative abnormal return (-0.00964), indicating that once the market processes the information, investors react negatively. This suggests greenwashing damages investors' confidence, and by Day 2 and Day 3, the market begins to recover slightly (Figure 5).

Cumulative Abnormal Return, to measure the total impact of the event over time, abnormal returns are aggregated across the event window. This measure is known as Cumulative Abnormal Returns and captures the overall stock market reaction before and after the event date (Figure 6).

$$CAR_{(t_1, t_2)} = \sum_{t=t_1}^{t_2} AAR_t \quad (3.4)$$

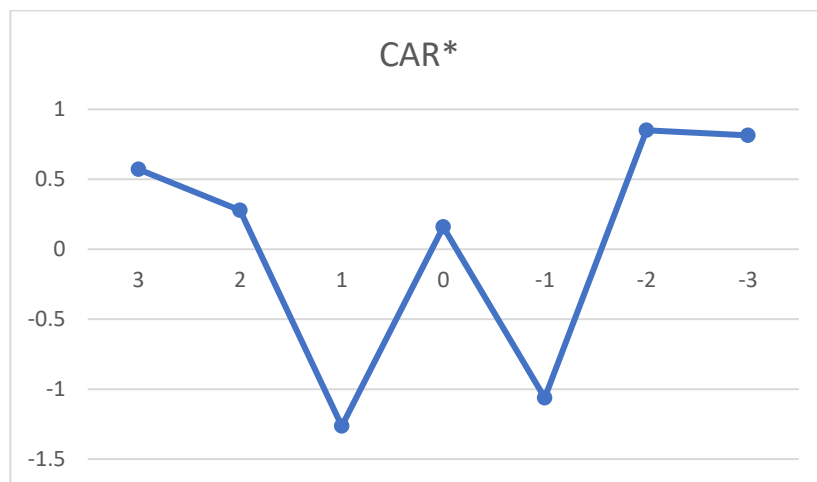


Figure 6 - Commutative Abnormal Returns

CAR values show that the event created significant volatility in stock returns. The finding indicates that greenwashing disclosures negative influence on investor perception and stock performance in the short term.

3.5 Market Model and Stock Returns

In an event study, the market model is applied to determine the return that a stock would be expected to achieve under normal market conditions, meaning when no specific event affects its performance. The main idea behind this method is that individual stock returns are often influenced by the overall movement of the market. When the market increases or decreases, many stocks tend to follow a similar direction, although the magnitude of the change may differ. For this reason, the model assumes that a portion of a stock's return can be explained by its relationship with the general market return. This relationship helps researchers estimate the expected return and later identify whether an event has caused any unusual changes in stock performance (Leonardo Bordignon, 2022).

$$R_{it} = \alpha_i + \beta_i R_{Mt} + \varepsilon_{it} \quad (3.5)$$

In Equation (3.5), the parameters α_i and β_i are the average return the stock i would generate when the market return is equal to zero, while β_i indicates how strongly the return of that stock responds to changes in the market portfolio, showing the degree to which the stock's performance moves with overall market fluctuations. R_{Mt} equals the market portfolio return at time t . ε_{it} represents the part of the stock i return at time t that is caused by a specific event related to the firm. The error term ε_{it} reflects the abnormal return associated with the event; it represents the part of the stock's return that cannot be explained by normal market movement and therefore considered the unexpected return caused by the event. The abnormal return for stock i at time t can be calculated by rearranging the equation presented as

$$\varepsilon_{it} = R_{it} - (\alpha_i + \beta_i R_{Mt}) \quad (3.6)$$

The estimation window:

$$\begin{aligned} E(\varepsilon_{it}) &= 0 \\ \sigma^2(\varepsilon_{it}) &= \sigma_{\varepsilon i}^2 \end{aligned} \quad (3.7)$$

In practical applications, researchers usually use abroad market index as a representation of the overall market portfolio. Compared with simpler approaches, the Market Model provides a more refined statistical method for estimating expected returns because it considers the relationship between individual stock performance and movements in the market. When the

influence of the market-wide movements is separated from the stock's return, the remaining variation becomes smaller, and as a result the abnormal returns show less fluctuation because the part driven by overall market changes has been removed. This approach helps provide a clearer understanding of how the event being analyzed affects stock performance, one of the main benefits of using the market model is linked to the goodness of fit of the regression which is measured by the R^2 through the ordinary least squares (OLS) estimation. “The larger the R^2 , the smaller the variance of the abnormal return, improving the better accuracy of the test Leonardo Bordignon (2022, p.34)”.

To begin with, the time period used for the estimation, along with the number of stocks in the sample, is large enough to reasonably assume a normal distribution of returns. In addition, it is assumed that the abnormal and cumulative abnormal returns of different stocks don't influence each other during the event window. Lastly, the level of variability in returns is considered to stay relatively stable over the entire event period. Many of the most well-known event studies have been carried out within the area of corporate finance; research in this field benefits from a well-established and widely accepted methodological framework. Typically, these studies focus on how abnormal returns behave in the days surrounding the announcement of a corporate event, in order to understand how the market reacts to new information.

An important requirement for carrying out a reliable event study is the ability to clearly identify the exact timing of the event being analyzed, commonly referred to as day 0. In addition, selecting suitable lengths for both the event window and the estimation window is essential for obtaining reliable results. The event window should not be too long, but it must still be wide enough to capture how investors react in the market. Therefore, it is important to consider typical market behavior and how rational investors respond to new information when defining this period.

In practice, researchers usually include several days both before and after the event date in the event window to capture any unusual movements in stock returns. At the same time, the estimation window needs to be long enough to provide a reliable basis for estimating the parameters of the Market Model. A common approach is to use a period that roughly covers one full year of trading days. In addition, both the size of the sample and the length of the estimation period should be sufficiently large to support the assumption that returns follow a normal distribution.

Evidence from past studies shows that stock prices tend to respond to new information. To evaluate whether these reactions are significant, researchers rely on measures such as cumulative abnormal returns (CAR) and average abnormal returns (AAR). CAR provides a

combined measure of abnormal returns for each stock over the event window, allowing us to observe the total effect of the event across the selected period. In contrast, the average abnormal return (AAR) represents the mean return across all stocks in the sample over the same time period. In addition, when applying the Market Model, a broad market index is typically used as a proxy for the market portfolio against which each stock is compared. In many cases, the firms included in the study are also part of this market index, making it a suitable benchmark for analysis.

This chapter has outlined the methodology used for the short-term event study, where the analysis focuses on a limited time frame and the event window extends only a few days beyond the event day 0. The two models presented provide a comparison between the parametric and non-parametric approaches, showing how each method offers its own advantages in the analysis. The Market Model works well in the event studies based on daily stock returns, particularly when the selected companies are included in well-known market indices like the S&P 500, Dow Jones, Euro Stoxx 50, or industry-specific indices such as those in the oil and gas sector.

The constant Mean Return Model provides a straightforward approach for measuring abnormal returns, allowing analysts to easily compare returns observed during the event window with those from the benchmark period.

The Market Model helps reduce the variability of abnormal returns by accounting for general market movements. Since a large part of a stock's return is often driven by overall market changes, removing this component allows the analysis to focus only on the firm-specific portion of the return. As a result, the remaining abnormal returns tend to be more stable and less noisy, which improves the accuracy and reliability of the findings.

Lastly research shows that analyzing one event at a time without overlapping events helps prevent the returns of different stocks in the sample from becoming interrelated.

3.6 Objective of methodology

The main objective of this methodology is to examine how stock prices react to greenwashing-related events by applying an event study approach. Specifically, the study aims to determine whether the announcement or disclosure of greenwashing information has a measurable impact on the returns of the affected firms.

To accomplish this, the methodology centers on estimating abnormal returns, which reflects the difference between the returns actually recorded and those that would be anticipated under normal market circumstances. The expected returns are derived using the Market Model,

as it considers overall market behavior and serves as a more dependable benchmark for comparison.

By examining abnormal returns within a selected time frame around the announcement date, the study aims to identify how the market responds in the short term to greenwashing related information. Furthermore, the calculation of Average Abnormal Return (AAR) and Cumulative Abnormal Returns (CAR) help to evaluate the impact of these events not only day by day but also across the full event window, providing a more complete view of their effect on stock performance.

Chapter 4

Data Analysis and Results

4.1 Global analysis

In this chapter, the focus is on analyzing the results of the event study implemented on 14 listed companies that belong to the S&P 500, Dow Jones U.S, FTSE 100, Euro Stoxx 50 sector, and GSPC, DJUSENT, AASGITR, FTSE, Stoxx 50 E indices are selected. The sample consists of firms that have been publicly associated with greenwashing allegations, as they represent highly capitalized companies committed to maintaining a virtuous image while operating in the greenwashing framework. In this context, the event under observation for performing the event study is picked out. The event date ($t=0$) is defined separately for each firm, based on the date when the greenwashing-related information was publicly disclosed. The stock returns, as well as the greenwashing ratings, came from the Yahoo Finance database using R software, and they include more than eight years of trading from September 2015 to January 2025. Once the sample of stocks and the event analyzed have been identified, the next step in conducting the event study is to define the time period during which the stock returns will be analyzed. The event window opens three days before the event date and closes three days after it.

The estimation window covers 185 trading days before the opening of the event window. To be more precise, according to Bloomberg, 185 is the average number of trading days per year. The estimation window closes when the event window opens, so the two windows don't overlap, ensuring the independence between the access returns during the benchmark period and the event period.

The study examines how stock prices react in the days immediately surrounding the publication of greenwashing. This approach evaluates how investors react to the announcement interpreting each company's released score as either favorable or unfavorable. The principle behind this is the efficient market hypothesis, which holds that markets promptly incorporate new public information into prices. As a result, fluctuations in a company's stock prices embed the discounted worth of its actual anticipated future cash flow. The main principle of this approach is that the impact of news on investors can be assessed by contrasting realized returns in the event period with the returns forecasted using a prior estimation period. This discrepancy is referred to as the abnormal return if the market reacts unfavorably to the greenwashing disclosure statistically meaningful negative abnormal returns are expected whereas a favorable response would lead to notably positive abnormal returns. The approach focuses on how

investors interpret and react to disclosures associated with greenwashing, using their collective response to reassess the company's value in the market.

The analysis conducted and outlined in this chapter is based on the Market Model introduced in chapter 3. The daily prices of the 14 stocks in the sample over the eight-year period are obtained from Yahoo Finance. Then, excess returns are computed as the difference between each stock return and risk-free asset, like US Treasury Bill. For the Market Model, also the excess returns of the Dow Jones, FTSE 100, Euro Stoxx 50 sector over the relevant period are calculated.



Figure 7 - Excess returns of 14 stocks from 2015 to 2019

The results show that expected returns around the event window are small and statistically insignificant, suggesting that the market did not respond strongly to the greenwashing event (Figure 7).

Table 2 - Statistical test for BP and Volkswagen

Day	AAR	z-value	P-value	z-value	p-value	CAR*	z-value	p-value
3	0.0047	0.6582	0.5104	0.6123	0.5403	0.5710	0.1526	0.8787
2	0.0022	0.3104	0.7562	0.2888	0.7727	0.2779	0.0743	0.9408
1	-0.0096	-1.3587	0.1742	-1.2641	0.2062	-1.2643	-0.3379	0.7354
0	0.0009	0.1227	0.9024	0.1141	0.9091	0.1585	0.0424	0.9662
-1	-0.0085	-1.1922	0.2332	-1.1092	0.2673	-1.0635	-0.2842	0.7762
-2	0.0063	0.8810	0.3783	0.8197	0.4124	0.8500	0.2272	0.8203
-3	0.0065	0.9107	0.3625	0.8473	0.3968	0.8147	0.2177	0.8276

Table 3 – Significance

			Significance
Day	CAAR	J-value	P-value
- 3, +3	0.0024	0.1255	0.4501

When examining the statistical test significance for BP and Volkswagen, the z-value for both AAR and CAR remain well below the critical threshold of 1.96, while all corresponding p-values are greater than 0.05. This indicates that the abnormal returns observed around the greenwashing events are not statistically significant. In other words, the changes in stock prices during the event window are likely driven by normal market fluctuations rather than a direct response to greenwashing-related information (Table 2).

The cumulative average abnormal return (CAAR) over the entire event window is also very small (0.0023), further confirming the absence of a strong market reaction. Moreover, the low j-value and its associated p-value (0.45) suggest that the overall impact of greenwashing events on stock prices is not statistically significant (Table 3).

Overall, these findings imply that the greenwashing incidents associated with BP and Volkswagen didn't have a meaningful effect on their stock price performance. Investors didn't react in a way that generated abnormal returns, which may indicate that such information was either not considered impactful or had already been incorporated into stock prices before the event.

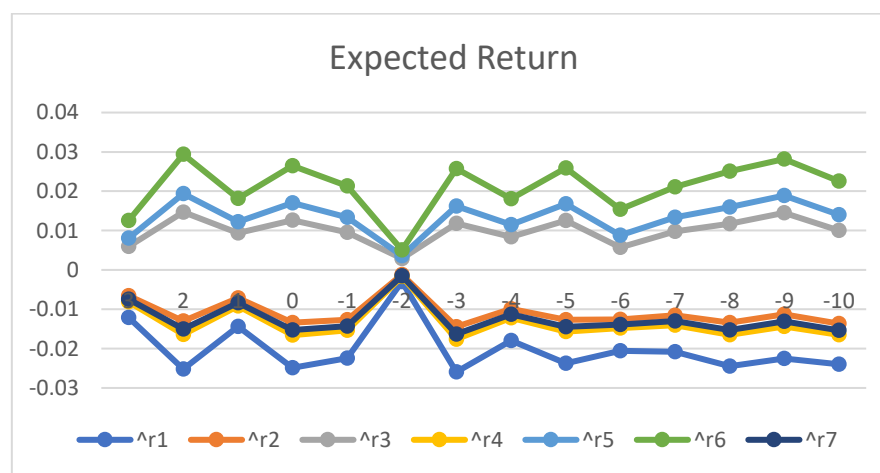


Figure 8 - Excess returns of 14 stocks from 2020 to 2021

The excess returns Figure 8 are mostly negative in the days before the event, showing a slightly unfavourable market sentiment. On the event day, returns remain negative, indicating an immediate negative reaction to the greenwashing news.

However, in the days after the event, returns become positive overall. On average, excess returns increase from about -0.7% before the event to around +0.8% after, suggesting a gain of roughly 1.5 percentage points. This indicates that although the initial response was negative, the market quickly adjusted and reacted more positively afterward.

Table 4 - Statistical test for Total Energies and Ryanair

Day	AAR	z-value	p-value	z-value	p-value	CAR*	z-value	p-value
3	0.0119	1.6086	0.1077	0.0119	0.9905	1.3440	0.3592	0.7195
2	-0.0100	-1.3548	0.1755	-0.0100	0.9920	-1.2165	-0.3251	0.7451
1	-0.0015	-0.2029	0.8392	-0.0015	0.9988	-0.2618	-0.0700	0.9442
0	-0.0150	-2.0261	0.0428	-0.0150	0.9881	-1.6980	-0.4538	0.6500
-1	-0.0107	-1.4491	0.1473	-0.0107	0.9915	-1.2852	-0.3435	0.7312
-2	-0.0039	-0.5246	0.5999	-0.0039	0.9969	-0.2851	-0.0762	0.9393
-3	0.0080	1.0847	0.2781	0.0080	0.9936	0.8758	0.2341	0.8149

Table 5 - Significance

			Significance
Day	CAAR	J-value	P-value
- 3, +3	-0.0211	-1.0825	0.8604

Starting with the Average Abnormal Returns (AAR), most days are not statistically significant, as their p-values are above 0.05. The only exception is day 0 (Event day), where the AAR is negative (-0.0150) and statistically significant ($P = 0.043$). This indicates that investors reacted negatively when the greenwashing information became public (see Table 4). Looking at the Cumulative Abnormal Returns (CAR), the value fluctuates between positive and negative, but none of the CAR results are statistically significant; all p-values are well above 0.05. This suggests that although there are short-term movements, the overall cumulative impact is not strong enough to be considered meaningful.

For the Cumulative Average Abnormal Return (CAAR), over the full window (-3 to +3), the value is negative (-0.0211), indicating an overall slight decline in returns. However, the j-value (-1.08) and its very high p-value (0.86) show that this effect is not statistically significant (Table 5).

In summary, the findings suggest that the greenwashing news triggered an immediate negative reaction on the event day, but this effect did not persist over time. Both energy companies and Ryanair experienced only a short-lived impact, and the market did not show strong or lasting evidence of penalizing greenwashing behavior.

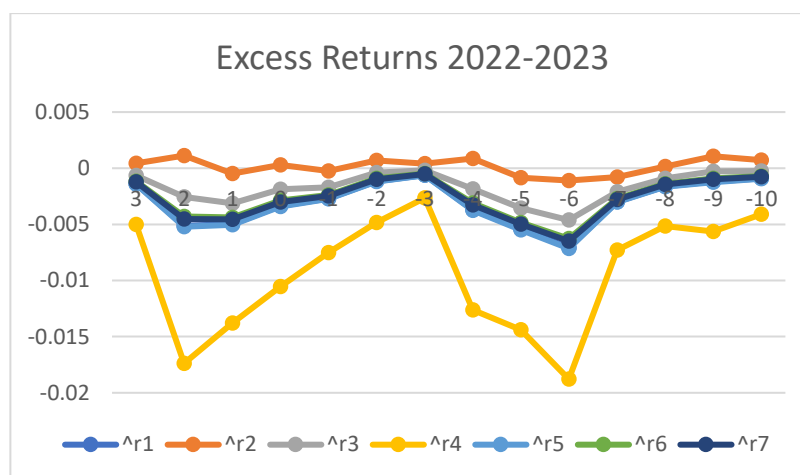


Figure 9 - Excess returns of 14 stocks from 2022 to 2023

In the days before the event, returns were already slightly negative, indicating mild skepticism or weak market sentiment. However, these negative values are relatively small and stable. On the event day, there is a clear drop in returns where all values become more strongly negative compared to previous days (Figure 9). This suggests that the market reacted unfavorably once the greenwashing information became public.

In the days after the event, returns remain negative across all observations. Although the magnitude of the decline becomes slightly smaller compared to the event day, the market does not fully recover. This indicates that the negative perception persists, even if the initial shock weakens over time. Overall, for Unilever, Coca-Cola, and Delta Airlines, the greenwashing news led to a clear immediate decline in returns, followed by a continued but less intense negative trend, suggesting a lasting but moderate loss of investor confidence (Table 6).

Table 6 - Statistical tests for Unilever, Coca-Cola, and Delta Airlines

Day	AAR	z-value	p-value	z-value	p-value	CAR*	z-value	p-value
3	-0.0016	-0.2873	0.7738	-0.00208	0.998337	-0.2051	-0.05482	0.956285
2	0.0075	1.3238	0.1855	0.009601	0.99234	1.009645	0.269839	0.787284
1	-0.0083	-1.4562	0.1453	-0.01056	0.991573	-0.92635	-0.24758	0.804461
0	0.0039	0.6881	0.4913	0.004991	0.996018	0.411408	0.109953	0.912446
-1	0.0036	0.6377	0.5236	0.004625	0.99631	0.408265	0.109113	0.913113
-2	-0.002	-0.3432	0.7313	-0.0024	0.9980	-0.1960	-0.0523	0.9582
-3	-0.0076	-1.3377	0.1809	-0.0097	0.9922	-0.8762	-0.2341	0.8148

Table 7 - Significance

			Significance
Day	CAAR	J-value	P-value
- 3, +3	-0.0044	-0.29291	0.615204

The results indicate that the effect of greenwashing disclosures on stock prices is weak and not statistically significant. The AAR values fluctuate around zero, showing that investors do not react consistently to such news, while the CARR values remain very small, suggesting no meaningful cumulative impact on firm value. Furthermore, the high p-values and low z-values across the event window indicate that these changes are not statistically different from zero and are likely due to normal market movements rather than the greenwashing event itself. The j-value also supports this conclusion, as it shows no significant overall reaction when considering all firms together. Overall, these findings suggest that the greenwashing allegations do not strongly influence stock prices in the short term, possibly because investors either do not perceive them as a serious financial risk or the information is already anticipated or unclear.

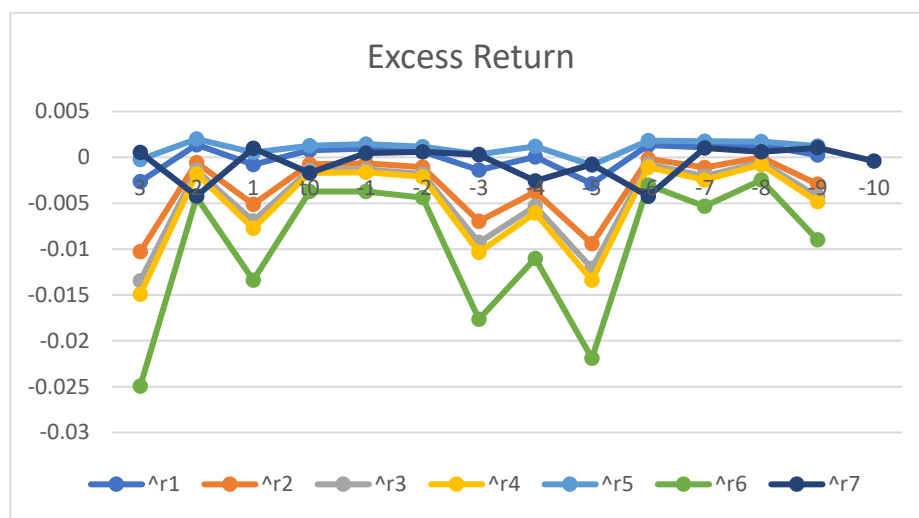


Figure 10 - Excess returns of 14 stocks from 2024 to 2025

The excess return values in Figure 10 indicate a noticeable change in stock performance around the greenwashing event. Before the greenwashing event, the excess return fluctuated around zero with relatively small magnitudes, showing a mix of slightly positive and negative values (e.g., 0.000557, -0.00263, 0.001381). This pattern suggests that before the event, the market reaction was relatively stable, with no strong abnormal performance and only minor daily deviations from expected returns. After the greenwashing event, however, the excess returns become more consistently negative and larger in magnitude, indicating a decline in abnormal performance. This one suggests that once the greenwashing information becomes evident, investors may react unfavorably, leading to negative abnormal returns and greater volatility compared with the period before the event. Overall, the pattern implies that

greenwashing is associated with a deterioration in excess returns, reflecting reduced investor confidence after the event.

Table 8 - Statistical Tests for Lululemon, ExxonMobil, HSBC, Starbucks, Shell

Day	AAR	z-value	p-value	z-value	p-value	CAR*	z-value	p-value
3	0	0	1	0	1	0	0	1
2	-0.0003	-0.0495	0.9604	-0.0004	0.9996	-0.0498	-0.0133	0.9893
1	0.0092	1.5131	0.1302	0.0124	0.9901	1.1772	0.3146	0.7530
0	-0.0034	-0.5638	0.5728	-0.0046	0.9963	-0.3286	-0.0878	0.9300
-1	-0.0012	-0.2003	0.8412	-0.0016	0.9986	-0.2138	-0.0571	0.9544
-2	-0.0059	-0.9687	0.3326	-0.0079	0.9936	-0.7763	-0.2074	0.8356
-3	0.0061	0.9998	0.3173	0.0082	0.9934	0.5141	0.1374	0.8907

Table 9 - Significance

			Significance
Day	CAAR	J-value	P-value
-3, +3	0.0044	0.2762	0.3912

The abnormal returns around the event are not statistically significant. In Table 8, the p-values are associated with the Average Abnormal Returns (AAR) for each day in the event window, ranging from approximately 0.13 to 0.96, all of which are far from the 0.05 threshold.

This means that the daily abnormal returns cannot be statistically distinguished from zero, suggesting that the market did not react strongly to the event on those specific days.

Similarly, the Cumulative Average Abnormal Return (CAAR) over the full event window (-3 to +3) is 0.0044, with a j-value of 0.2762 and a p-value of 0.3912. The j-value is the test statistic used to evaluate whether the cumulative abnormal return is significantly different from zero. Because the associated p-value (0.3912) is so much higher than 0.05, the CAAR is not statistically significant. Therefore, the results suggest that the event did not produce a statistically significant market reaction across the sampled companies. In other words, investors did not systematically adjust stock prices in response to the event, and any observed abnormal returns are likely to be due to normal market fluctuations rather than the event itself.

These are the excess returns of eight years of 14 companies before and after greenwashing from 2015 to 2025, so to grasp the impact of the disclosure on stock prices year by year, eight different event studies are performed. The estimation window lasts 185 days, and the event window includes 7 days, i.e., 3 days before day 0, the event date, and 3 days after day 0. The structure of the relevant periods is the same each year across the study. In event studying analysis, it is statistically significant.

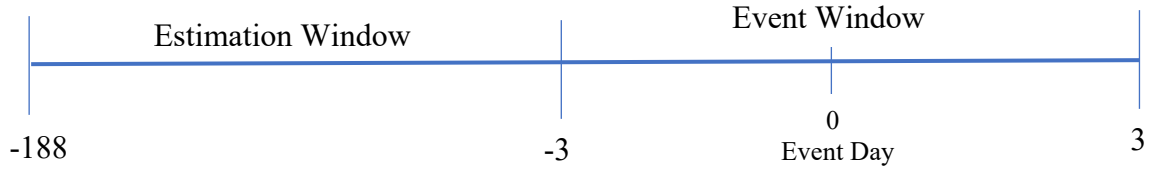


Figure 11 - The timeline of the eight event studies

Here, $T = -188$, $T_1 = -3$, $(T - T_1) = -185$, $T_2 = 3$. Some experiments with narrower event windows, symmetrical and asymmetrical with respect to day 0, have been performed. The regression result is the same. After imposing the restrictions of (Figure 11), R software was run, it extracted the excess returns of 14 stocks and the benchmark index over the estimation window. The Market Model was applied to each stock in the sample as follows:

$$R_{it} = \alpha_i + \beta_i R_{AASGITR} + \varepsilon_{it} \quad (4.1)$$

The excess returns for both the individual stocks and the AASGITR market index are represented by R_{it} and $R_{AASGITR}$. The values of $\hat{\alpha}_i$ and $\hat{\beta}_i$ are calculated using OLS, where each stock's return R_{it} is regressed on the market return $R_{AASGITR}$. Following the estimation of 14 regressions, the abnormal return for each stock over the event window was determined using the following approach:

$$AR_{i[-3,3]} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{AASGITR}) \quad (4.2)$$

Through the above formula provided the abnormal return for each stock is provided for the event window, i.e., 7 days. With a duration of 185 trading days, the estimation window is large enough to reasonably assume that:

$$\widehat{AR}_{it} \sim N[0, \sigma_{\varepsilon i}^2] \quad (4.3)$$

Because:

$$\sigma^2(\widehat{AR}_{it}) = \sigma_{\varepsilon i}^2 + \frac{1}{T_1 - T} \left[1 + \frac{(R_{Mt} - \hat{\mu}_{Mt})^2}{\hat{\sigma}_{Mt}^2} \right] \quad (4.4)$$

With:

$$\frac{1}{185} \left[1 + \frac{(R_{Mt} - \hat{\mu}_{Mt})^2}{\hat{\sigma}_{Mt}^2} \right] \cong 0 \quad (4.5)$$

Once the normal return for each stock on each day of the event window is obtained, the analysis needs to be performed on two measures, the cumulative abnormal return (CAR) and the average abnormal return (AAR). The CAR is an aggregate measure of abnormal returns stock-by-stock over the event period.

The AAR is an average measure of the abnormal returns of all stocks in the sample day by day over the event window.

4.2 The procedure used for the Event Study of RDS.A stock during the first year

Shell represents the first company in the sample of listed firms that are part of the FTSE 100 sector benchmark index. The methodology used in this thesis is explained in detail using this specific time series as an example. Once the procedure is established, the same approach can easily be extended to the other stocks, where the analysis is repeated systematically and recursively. In particular, the stock of shell is used to illustrate the methodology, which is then consistently applied to all the stocks included in the sample over the eight-year study period. The relevant event is the disclosure of greenwashing on 2025/01/15. The event window counts 6 trading days from 2025/01/15 to 2025/01/21. The estimation window lasts 185 trading days and closes on 2025/01/1. After calculating the excess returns for the stock of RDS.A and the FTSE 100 sector index over the eight-year study period, the observations corresponding to the estimation window were then selected and organized on a yearly basis for further analysis. The Market Model for RDS.A is given by:

$$R_{RDS.At} = \alpha_{RDS.A} + \beta_{RDS.A} R_{AASGITRt} + \varepsilon_{RDS.At} \quad (4.6)$$

Where $R_{RDS.At}$ and $R_{AASGITRt}$ are excess returns of Shell stock AASGITR market index. The abnormal returns of the Shell stock over the event window, i.e. (-3 to +3) are calculated as:

$$\widehat{AR}_{RDS.A[-3,+3]} = R_{RDS.A[-3,+3]} - (\hat{\alpha}_{RDS.A/B} + \hat{\beta}_{RDS.A/B} R_{AASGITR[-3,+3]}) \quad (4.7)$$

In particular, the RDS.A stock's abnormal returns are normally distributed as

$$\widehat{AR}_{RDS.A[-3,+3]} \sim N[0, \sigma^2_{\varepsilon_{RDS.At}}] \quad (4.8)$$

The parameters $\hat{\alpha}_{RDS.A/B}$ and $\hat{\beta}_{RDS.A/B}$ are estimated over the 185 days estimation window, i.e. ([-188, -3]) through OLS, by regression $R_{RDS.At}$ on $R_{AASGITRt}$.

Table 10 - The result of RDS.A OLS estimation

SUMMARY OUTPUT

Regression Statistics	
Multiple R	0.021847803
R ²	0.000477326
Adjusted R ²	-0.00821418
Standard Error	0.008982819
Observations	117

ANOVA					
	df	SS	MS	F	Significance F
Regression	1	4.43145E-06	4.43145E-06	0.054918759	0.815131915
Residual	115	0.00927947	8.0691E-05		
Total	116	0.009283901			

	Coefficients	Standard Error	t Stat	P-value	Lower 95%	Upper 95%
α	0.000553354	0.000832194	0.664933917	0.507424027	-0.001095062	0.00220177
β	0.021654207	0.092402119	0.234347517	0.815131915	-0.161376607	0.204685021

The regression results estimate the relationship between the stock returns and the market returns using the market model. The R^2 value (0.00048) is extremely low, indicating that the market return explains almost none of the variation in the stock's returns during the estimation period. This is also reflected in the multiple R (0.0218), which shows a very weak correlation between the two variables. In the above Table 10, the F statistic (0.0549) with a significance F of 0.8151 is far above the conventional significance level of 0.05, meaning that the overall regression model is not statistically significant.

Looking at the estimated coefficients, the (α) is 0.000553, which represents the average abnormal return when the market is zero. However, its p-value (0.5074) is greater than 0.05, indicating that this intercept is not statistically different from zero. The (β) is 0.02165, suggesting that the stock has a very low sensitivity to movements. However, the p-value for bet (0.8151) is also much higher than 0.05, meaning that the relationship between the stock and market index is not statistically significant. Additionally, the confidence interval for beta ranges from -0.161 to 0.205, which includes zero. The results suggest that during the estimation window, the stock returns are not significantly related to the market index, and the market model does not strongly explain the stock's return behavior. The test statistics for each abnormal return and corresponding p-value are computed:

$$\widehat{SAR}_{RDS.A[-3,+3]} = \widehat{AR}_{RDS.A[-3,+3]} / \sqrt{\sigma^2(\widehat{AR}_{RDS.A[-3,+3]})} \quad (4.10)$$

Where the variance of each abnormal return in the event period is given by:

$$\sigma^2(\widehat{AR}_{RDS.A[-3,+3]}) = \sigma^2_{\varepsilon RDS.A/B} \quad (4.11)$$

The variance-covariance matrix and variance of each stock have been calculated using the Excel program over the entire period of the study. All computations and a complete list of results for the eight years under observation are shown in the table below.

Table 11 - The covariance matrix of 7 companies for eight years

	AR1	AR2	AR3	AR4	AR5	AR6	AR7
AR1	7.99954E-05	-1.58039E-05	1.52221E-06	-1.8154E-05	-7.18397E-06	3.5311E-05	1.63073E-05
AR2	-1.07E-05	0.000409034	-2.66065E-05	2.7825E-05	-3.68853E-05	-2.07156E-05	-2.05027E-05
AR3	-7.23E-06	1.98E-06	0.000176095	3.22701E-07	3.97645E-05	-2.07656E-07	3.73149E-05
AR4	-1.41E-06	2.76E-05	8.54E-06	0.000142276	4.9194E-05	5.97337E-06	3.26001E-05
AR5	-2.41E-06	-3.27E-05	2.99E-06	4.04E-05	0.000151629	-9.56311E-06	9.92974E-05
AR6	1.35E-05	-8.10E-06	-1.69E-05	1.29E-05	-4.44E-06	8.0923E-05	-9.75202E-06
AR7	4.90E-06	-3.12E-05	5.48E-05	1.89E-05	1.01E-04	-3.77E-06	0.000155971
AR8	7.14E-06	1.32E-05	-1.07E-05	6.84E-06	2.34E-05	1.42E-05	2.77E-05
AR9	-6.94E-06	9.93E-05	1.67E-05	2.67E-05	-1.07E-05	3.09E-05	-4.41E-05
AR10	1.20E-05	9.18E-06	7.03E-06	-9.73E-06	1.28E-05	7.60E-06	1.76E-05
AR11	-4.87E-06	-2.46E-05	5.63E-06	4.46E-05	1.18E-04	-2.15E-06	1.05E-04
AR12	-3.41E-06	-3.06E-05	-1.63E-06	3.78E-05	1.19E-04	-1.15E-05	1.11E-04
AR13	8.91E-06	4.92E-05	3.21E-05	3.89E-05	4.55E-06	6.04E-06	-8.59E-06
AR14	-5.36E-06	-2.48E-06	3.46E-05	2.78E-05	8.02E-05	5.01E-06	1.57E-04

The covariance matrix reports the covariance between the abnormal returns (AR) across the different days of the event window. Covariance measures how two variables move together; positive values indicate that abnormal returns tend to move in the same direction, while negative values suggest opposite movements. The diagonal elements represent the variance of each abnormal return, whereas the off-diagonal elements show the covariance between different days. In this matrix, most values are very small and close to zero, indicating weak co-movement between abnormal returns over time. This suggests that the abnormal returns are largely independent across the event window. Each average abnormal return has been obtained as:

$$\widehat{AAR}_{[-3,+3]} = \frac{1}{117} \sum_{i=1}^{117} \widehat{AR}_{i[-3,+3]} \quad (4.9)$$

Where $[-3, 3]$ is the event window, i is each stock of the sample, and $\widehat{AR}_i[-3, 3]$ is each abnormal return stock-by-stock in the event window. Moreover, the program provided the test statistics for each average abnormal return and the relevant p-value according to:

$$\widehat{AAR}_{[-3,3]} = \frac{\widehat{AAR}_{[-3,3]}}{\sqrt{\sigma^2(\widehat{AAR}_{[-3,3]})}} \quad (4.10)$$

Where the variance of each average abnormal return in the event period is:

$$\sigma^2(\widehat{AAR}_{[-3,3]}) = \frac{1}{117^2} \sum_{i=1}^{117} \sigma^2(\widehat{AR}_{i[-3,3]}) \quad (4.11)$$

The variance of each abnormal return equals to: $\sigma^2(\widehat{AR}_{i[-3,3]}) = \sigma_{\varepsilon i}^2$ as has been demonstrated above. The cumulative abnormal return (CAR) represents the total abnormal return accumulated for each stock throughout the event window $[-3, +3]$. It is calculated by summing the abnormal returns observed during this period for a specific stock. For illustration, the stock of Shell is used as an example to demonstrate how the CAR is obtained.

$$\widehat{CAR}_{RSD.A/B}(T_1, T_2) = \sum_{t=T_1}^{T_2} \widehat{AR}_{RSD.A[-3,+3]} \quad (4.12)$$

where T_1 and T_2 are the opening and closing dates of the event window, respectively. And $\widehat{AR}_{RSD.A[-3,+3]}$ are the abnormal returns of the stock of RSD.A during the event window, which were calculated in the initial stage of the event study procedure. This is the calculation to obtain the RSD.A/B stock's CAR, which has been repeated for all 14 stocks within the sample. Moreover, knowing that $\sigma^2(\widehat{AR}_{RSD.A[-3,+3]}) = \sigma_{\varepsilon RSD.A}^2$ and it is constant through time, the variance of $\widehat{CAR}_{RSD.A}(T_1, T_2)$ is computed as:

$$\sigma^2(\widehat{CAR}_{RSD.A}(T_1, T_2)) = (T_2 - T_1 + 1) \sigma_{\varepsilon RSD.A}^2 \quad (4.13)$$

The variance estimator for each cumulative abnormal return (CAR) is based on the conditional variance of the abnormal returns.

A sufficiently long estimation window is used to minimize potential estimation errors in the parameters. Under the same assumptions applied to average abnormal returns, cumulative abnormal returns are also considered to follow a normal distribution. For illustration, this approach is applied to the stock of RSD.A/B

$$\widehat{CAR}_{RSD.A}(T_1, T_2) \sim N[0, (T_2 - T_1 + 1) \sigma_{\varepsilon RSD.A}^2] \quad (4.14)$$

Similar to the Average Abnormal Returns (AAR), the program was also designed to calculate the test statistics and the associated p-value for each Cumulative Abnormal Return (CAR) during the event window. This allows the statistical significance of the cumulative abnormal returns to be evaluated throughout the event period. The test statistics are obtained as follows:

$$\widehat{SCAR}_{RSD.A/B}(T_1, T_2) = \frac{\widehat{CAR}_{RSD.A}(T_1, T_2)}{\sqrt{\sigma^2(\widehat{CAR}_{RSD.A}(T_1, T_2))}} \quad (4.15)$$

As an illustration, the standardized cumulative abnormal return (SCAR) for the stock of RSD.A/B is calculated over the event window. After standardization, this measure follows a standard normal distribution, which allows the statistical significance of the cumulative abnormal return to be tested: $\widehat{SCAR}_{RSD.A}(T_1, T_2) \sim N(0,1)$. The methodology described above was systematically repeated for each stock included in the study, applying the same procedure step by step to all companies in the sample.

Chapter 5

Conclusion and Limitations

This thesis examined the relationship between greenwashing disclosures and stock market reactions by applying an event study methodology to a sample of fourteen large publicly listed companies included in major international indices such as the S&P 500, Dow Jones U.S., FTSE 100, and Euro Stoxx 50. The main objective of the study was to determine whether investors react significantly when information related to greenwashing practices becomes publicly available.

To address this research question, the analysis was conducted using the Market Model and an event study framework. Stock prices data covering more than eight years, from September 2015 to January 2025, were collected and analyzed. The event window was defined as the period from three days before the event date to three days after the event date, while the estimation window consisted of 185 trading days before the event window. Abnormal returns were calculated as the difference between actual stock returns and expected returns estimated through the Market Model. The analysis then focused on Average Abnormal Return (AAR), Cumulative Abnormal Returns (CAR), and Cumulative Average Abnormal Returns (CAAR) in order to evaluate the market reaction around greenwashing disclosures.

The empirical results indicate that the impact of greenwashing allegations on stock price performance is generally weak and statistically insignificant. In most cases, the abnormal returns observed during the event window fluctuate around zero and don't exceed conventional significance thresholds. Although some negative abnormal returns appear on the event day for certain firms, such as in the case of TotalEnergies and Ryanair, these reactions are short-lived and don't persist over the entire event window. The cumulative abnormal returns across companies remain relatively small, and the overall CAAR values do not indicate a strong or systematic market reaction.

These findings suggest that investors do not consistently penalize companies following greenwashing disclosures. One possible explanation is that financial markets may not interpret such information as having a substantial impact on future corporate profitability. Alternatively, investors may already anticipate environmental controversies in industries that face high environmental scrutiny, such as energy or transportation. In this case, part of the information may already be incorporated into stock prices before the official disclosure occurs. Another possible explanation is that greenwashing allegations may affect corporate reputation more

strongly than short-term financial performance, which may limit their immediate impact on stock prices.

The results of this study also highlight differences in the market reactions across firms and time periods. Some companies experience slightly stronger negative abnormal returns around the event date, while others show almost no reaction. These variations may be related to differences in industry characteristics, company reputation, investor expectations, and the level of media attention associated with the disclosure. Companies operating in environmentally sensitive sectors may face greater scrutiny from investors and stakeholders, while firms with strong market positions or diversified activities may experience less pronounced financial consequences.

Despite providing useful insights, this research is subject to several limitations. The sample size is relatively small, and the analysis focuses on a limited number of large companies. In addition, the event window is relatively short, which may not capture longer-term adjustments in stock prices. Furthermore, identifying the exact event date of greenwashing disclosures can be challenging, as information may circulate gradually through media coverage before becoming widely recognized by investors. These factors may reduce the ability of the event study methodology to fully capture the market impact of greenwashing events.

Future research could extend this analysis by considering larger samples of companies, different industries, and longer event windows to capture potential long-term effects of environmental controversies. In addition, future studies could incorporate alternative measures of corporate sustainability performance, media coverage, or investor sentiment to better understand how environmental disclosures influence financial markets. Examining the relationship between greenwashing and other financial indicators, such as trading volume, volatility, or long-term value, may also provide additional insights.

In conclusion, the results of this thesis suggest that greenwashing does not generate consistent reactions in stock markets in the short term. Although some temporary negative reactions are observed around the event date, the overall cumulative impact on stock prices remains limited. These findings contribute to the growing literature on environmental disclosure and financial markets by providing evidence that the immediate market response appears to be relatively weak.

References

- Ann C. Logue. (n.d.). Are Markets efficient? How Eugene Fama kicked off a controversy. *Journal of Business*.
- Aouadi, A., & Marsat, S. (2018). Do ESG Controversies Matter for Firm Value? Evidence from International Data. *Journal of Business Ethics*, 151(4), 1027–1047. <https://doi.org/10.1007/s10551-016-3213-8>
- Delmas, M. A., & Burbano, V. C. (2011). The Drivers of Greenwashing. <https://journals.sagepub.com/doi/10.1525/cmr.2011.54.1.64>
- Eugene F. Fama, Lawrence Fisher, Michael C. Jensen, & Richard Roll. (1969). The Adjustment of stock prices. *International Economic*, 10(1 Feb 1969). <https://www.anderson.ucla.edu/documents/areas/fac/finance/1969-1.pdf>
- Flammer, C. (2013). Corporate social responsibility and shareholder reaction: The environmental awareness of investors. *Academy of Management Journal*, 56(3), 758–781. <https://doi.org/10.5465/amj.2011.0744>
- Frances Bowen, J. A. A.-C. (2014). Greenwashing in Corporate Environmentalism Research and Practice. 107–112.
- Friede, G., Busch, T., & Bassen, A. (2015). ESG and financial performance: aggregated evidence from more than 2000 empirical studies. *Journal of Sustainable Finance and Investment*, 5(4), 210–233. <https://doi.org/10.1080/20430795.2015.1118917>
- George A. Akerlof, A. Michael Spence, & Joseph E. Stiglitz. (2001). Asymmetric information. <https://www.nobelprize.org/prizes/economic-sciences/2001/press-release/>
- Hu, H., Zhang, T., & Dong, H. (2026). The signaling power of ESG reports: How corporate sustainability disclosure shapes investment decisions in China. *International Review of Financial Analysis*, 109, 104691. <https://doi.org/10.1016/j.irfa.2025.104691>
- Karpoff, J. M., Lott, Jr., J. R., & Wehrly, E. W. (2005). The Reputational Penalties for Environmental Violations: Empirical Evidence. *The Journal of Law and Economics*, 48(2), 653–675. <https://doi.org/10.1086/430806>
- Khan, M., Serafeim, G., & Yoon, A. (n.d.). Corporate Sustainability: First Evidence on Materiality. Retrieved <http://ssrn.com/abstract=2575912> Electronic copy available at: <https://ssrn.com/abstract=2575912> Electronic copy available at: <http://ssrn.com/abstract=2575912>
- Khotari, S. P., & Warner, J. B. (2006). “Econometrics of Event Studies.”

- Leonardo Bordignon. (2022). The Impact of the ESG Ratings on Returns: an Event Study Perspective. <https://unitesi.unive.it/retrieve/16137799-0a7a-4f7e-b3fd-c3fdb292bd07/867254-1280772.pdf>
- Lyon, T. P., & Montgomery, A. W. (2015a). The Means and End of Greenwash. *Organization and Environment*, 28(2), 223–249. <https://doi.org/10.1177/1086026615575332>
- Lyon, T. P., & Montgomery, A. W. (2015b). The Means and End of Greenwash. *Organization and Environment*, 28(2), 223–249. <https://doi.org/10.1177/1086026615575332>
- Mackinlay, 1996, as cited in Leonardo Bordignon. (2022). The Impact of the ESG Ratings on Returns: an Event Study Perspective. <https://unitesi.unive.it/retrieve/16137799-0a7a-4f7e-b3fd-c3fdb292bd07/867254-1280772.pdf>
- Mackinlay, C. (1997). MacKinlay-1996-Event-Studies-in-Economics-and-Finance. *Journal of Economic Literature*. <https://www.bu.edu/econ/files/2011/01/MacKinlay-1996-Event-Studies-in-Economics-and-Finance.pdf>
- McWilliams, A., & Siegel, D. (1997). EVENT STUDIES IN MANAGEMENT RESEARCH: THEORETICAL AND EMPIRICAL ISSUES. In *Management Journal* (Vol. 40, Number 3).
- Mohn, E. (2025). Information Asymmetry. *Journal of Financial Economics*.
- Terra Choice. (2007). The Six Sins of Greenwashing.
- Martin Sewell. (2012, October 17). Efficient Market Hypothesis. *International Journal Of Statistics and Probability*. <http://dx.doi.org/10.5539/ijsp.v1n2p164>
- Zhang, C. , Luo, L. , & Tang, Q. (2022). (2022). Greenwashing and market value of firms: An empirical study. *International Journal of Production Economics*, 284, 109606. <https://doi.org/10.1016/j.ijpe.2025.109606>

Annexes

Annex A – Expected Returns (2015 - 2025)

This appendix presents the expected returns estimated for the selected firms. The methodology used for calculating expected returns is discussed in chapter 3.

Table 12 - Expected Return

Date	Expected Return													
	^r1	^r2	^r3	^r4	^r5	^r6	^r7	^r8	^r9	^r10	^r11	^r12	^r13	^r14
12/9/2019	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	-
	0.000	1058	2322	0659	0228	015	0585	1017	0.001	2435	0453	0295	1725	0.000
	7026	1	5	3	7	58	6	3	4203	3	8	9	1	8924
12/6/2019	-	0.00	0.00	0.00	6.08	0.00	0.00	0.00	-	-	0.00	2.89	0.00	-
	0.000	1313	2663	0967	3E-	017	0363	1161	0.000	0.00	0666	7E-	1776	0.000
	8171	1	4	5	05	48	3	1	6024	3035	7	05	7	9218
12/5/2019	-	0.00	0.00	0.00	6.20	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	-
	0.000	0.00	0644	0857	0.00	4E-	1680	0309	0.005	0.00	0594	1895	1470	0.000
	1386	0197	1	8	1654	05	3	3	447	0517	5	5	8	7474
12/4/2019	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	-
	0.000	0738	1894	0272	0591	013	0864	0836	0.002	1683	0186	0703	1660	0.000
	5589	3	9	8	8	19	5	9	4463	1	7	5	3	8554
12/3/2019	-	0.00	0.00	0.00	0.00	8.77	0.00	0.00	-	0.00	0.00	0.00	0.00	-
	0.000	0146	1103	0442	1263	1E-	1380	0503	0.004	0291	0307	1457	1540	0.000
	293	7	7	4	7	05	6	2	3445	4	4	5	5	7871
12/2/2019	-	0.00	0.00	0.00	0.00	0.00	1.18	0.00	-	0.00	0.00	0.00	0.00	-
	0.001	1743	3238	1487	0549	020	5E-	1403	0.000	4046	1025	0577	1863	0.000
	0104	1	5	3	2	7	05	7	7774	6	9	1	9	9715
11/29/19	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	-	-
	0.001	1990	3569	1786	0830	022	0227	1543	0.001	4628	1232	0892	0.00	0.001
	1215	5	2	2	1	54	6	2	5708	4	5	2	1914	0001
12/24/18	8.292	0.00	1.50	0.00	0.00	2.52	0.00	3.12	-	0.00	0.00	0.00	-	-
	E-05	0689	4E-	1453	2213	2E-	2110	8E-	0.007	1676	1006	2523	0.00	0.000
		9	05	6	8	05	2	05	0284	4	2	6	1371	6904
12/18/20	-	8.40	0.00	0.00	0.00	7.61	0.00	0.00	-	7.33	0.00	0.00	-	-
	0.000	2E-	0896	0629	1439	3E-	1515	0415	0.004	4E-	0436	1655	0.00	0.000
	2233	06	3	8	8	05	8	7	8419	05	9	1	1509	7692
12/17/20	-	0.00	0.00	0.00	0.00	0.00	0.00	0.00	-	0.00	0.00	0.00	0.00	-
	0.000	0649	1776	0165	0692	012	0941	0786	0.002	1474	0112	0816	1642	0.000
	519	6	2	5	6	53	9	9	7309	4	6	5	3	8452
12/6/2021	0.012	-	-	-	-	-	-	-	-	-	-	-	-	-
	0844	0.02	0.01	0.02	0.02	0.00	0.02	0.01	0.023	0.02	0.02	0.02	0.02	0.024
	3	519	44	487	242	299	594	798	71	058	083	447	255	01
12/3/2021	0.006	-	-	-	-	-	-	-	-	-	-	-	-	-
	5890	0.01	0.00	0.01	0.01	0.00	0.01	0.00	0.012	0.01	0.01	0.01	0.01	0.013
	1	303	714	343	267	12	443	994	66	255	149	343	125	63
12/2/2021	0.005	-	-	-	-	0.00	-	-	-	-	-	-	-	-
	9453	0.01	0.00	0.01	0.00	290	0.01	0.00	0.012	0.00	0.00	0.01	0.01	0.010
	99	47	941	2639	9579	4	1816	8416	549	5753	9809	1736	4526	037

12/1/2021	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.008	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.015	0.01	0.01	0.01	0.01	0.016
	1021	638	914	658	535	169	76	215	7	476	407	647	436	49
11/3	0.008					0.00								
0/20	0613	0.01	0.01	0.01	0.01	359	0.01	0.01	0.016	0.00	0.01	0.01	0.01	0.014
21	71	9382	2205	7041	3334	6	6247	1514	804	8843	3405	5985	8878	033
11/2	0.012					0.00								
9/20	5768	0.02	0.01	0.02	0.02	507	0.02	0.01	0.025	0.01	0.02	0.02	0.02	0.022
21	08	9372	8169	6434	1348	3	5703	8125	884	5437	1079	5052	8164	559
11/2	0.007	-	-	-	-	-	-	-	-	-	-	-	-	-
6/20	4918	0.01	0.00	0.01	0.01	0.00	0.01	0.01	0.014	0.01	0.01	0.01	0.01	0.015
21	9	503	834	531	427	149	632	126	47	387	303	525	311	34
	-													
1/4/2	0.003	-	-	-	-	-	-	-	-	-	-	-	-	-
021	7240	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.008
	5	669	336	747	758	026	843	574	89	837	662	768	536	22
12/3	0.009					0.00								
1/20	9148	0.02	0.01	0.02	0.01	420	0.02	0.01	0.020	0.01	0.01	0.01	0.02	0.017
20	82	3483	4653	0897	6624	3	0128	4227	532	1549	6555	9707	269	533
12/3	0.003	-	-	-	-	-	-	-	-	-	-	-	-	-
0/20	3262	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.006	0.00	0.00	0.00	0.00	0.007
20	3	581	283	665	688	013	76	516	09	779	595	688	454	47
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/20	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.005	0.00	0.00	0.00	0.00	0.000
23	39	511	497	335	27	116	061	369	42	705	298	163	12	91
12/1	-	-	-	-	-	0.00	-	-	-	-	-	-	-	-
4/20	0.000	0.00	0.00	0.00	0.00	070	0.00	0.00	0.000	0.00	0.00	0.00	0.00	0.000
23	443	1127	049	0299	026	4	042	0857	86	109	079	0163	1055	712
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3/20	0.000	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.003	0.00	0.00	0.00	0.00	0.000
23	64	256	314	186	171	04	019	183	56	462	209	09	028	25
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2/20	0.005	0.01	0.01	0.01	0.00	0.00	0.00	0.01	0.014	0.01	0.00	0.00	0.00	0.004
23	01	738	378	053	751	483	264	263	4	878	728	515	564	11
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/20	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.005	0.00	0.00	0.00	0.00	0.000
23	42	521	503	341	274	119	063	376	49	715	301	165	124	94
12/8/2023	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.000
	15	429	438	287	238	092	048	309	82	627	269	139	091	7
12/7/2023	-	-	-	-	-	-	-	-	-	-	-	-	-	-
	0.001	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.004	0.00	0.00	0.00	0.00	0.000
	22	452	455	301	247	099	052	326	99	649	277	146	099	76
12/3	-					0.00								
0/20	0.002	0.00	0.00	0.00	0.00	230	0.00	0.00	0.003	0.00	0.00	0.00	0.00	0.002
22	015	6465	3349	3421	1828	1	1304	4748	046	4007	1075	1695	2987	102
12/2	-					0.00								
9/20	0.001	0.00	0.00	0.00	0.00	170	0.00	0.00	0.001	0.00	0.00	0.00	0.00	0.001
22	43	4477	1921	2258	105	6	0974	3299	592	2107	0378	1125	2267	584
1/23/2025	-													
1/22/2025	0.000	-	-	-	-	0.00	-	-	3.048	-				0.000
	557	0.00	0.00	0.00	0.00	094	0.00	0.00	24E-	0.00	0.00	0.00	0.00	24414
		263	1381	08	0773	2	0638	14	05	288	1343	1073	131	3
1/21/2025	0.000	-	-	-	-	-	-	-	0.003	-	-	-	-	0.002
	421	0.01	0.00	0.00	0.00	0.00	0.00	0.00	7594	0.00	0.00	0.00	8.09	92436
		028	059	513	077	066	108	697	2	941	015	112	E-06	8
1/17/2025	0.000	-	-	-	-	-	-	-	0.005	-	-	-	-	0.004
	364	0.01	0.00	0.00	0.00	0.00	0.00	0.00	3345	0.01	0.00	0.00	0.00	24124
		346	141	692	14	133	18	929	5	212	078	204	053	7

		-	-	-	-	-	-	-	-	-	-	-	-	-
1/16/ 2025	0.000 338	0.01 494	0.00 179	0.00 776	0.00 17	0.00 164	0.00 213	0.01 037	0.006 0654	0.01 338	0.00 107	0.00 246	0.00 078	0.004 85230
1/15/ 2025	0.000 599	0.00 025	0.00 1993	0.00 0543	0.00 1251	0.00 144	0.00 1173	0.00 0335	0.001 2082	0.00 085	0.00 1808	0.00 1756	0.00 1715	0.001 22884
1/14/ 2025	0.000 16	0.02 494	0.00 437	0.01 341	0.00 371	0.00 373	0.00 437	0.01 765	0.011 0159	0.02 19	0.00 302	0.00 533	0.00 248	0.008 99116
12/3 1/20 24	0.000 602	0.00 011	0.00 2028	0.00 062	0.00 1278	0.00 146	0.00 9	0.00 1203	0.001 2755	0.00 074	0.00 1835	0.00 1795	0.00 1738	0.001 28505
12/3 0/20 24	0.000 646	0.00 2408	0.00 2677	0.00 2043	0.00 1784	0.00 199	0.00 1769	0.00 2269	0.002 5229	0.00 141	0.00 2327	0.00 2518	0.00 2166	0.002 32795

Annex B – Abnormal Returns (AR)

This appendix provides the calculated abnormal returns based on the market model during the event window.

Table 13 - Abnormal Return

Date	Abnormal Return													
	AR1	AR2	AR3	AR4	AR5	AR6	AR7	AR8	AR9	AR10	AR11	AR12	AR13	AR14
12/9/2019	0.00 6266 4	0.00 5908 6	0.01 4777 2	0.00 2604 8	0.00 1798 8	0.00 4171 1	0.00 8065 9	0.00 3802 9	0.00 5107 6	0.00 7777 3	0.00 2165 3	0.00 0.00 2133	0.00 0.00 2408	0.00 1989 9
12/6/2019	0.00 7269	0.00 7387 8	0.00 8330 2	0.00 0117 5	0.00 0409 9	0.00 7006 4	0.00 2518 9	0.00 1624 3	0.01 8020 7	0.00 3483 1	0.00 7295 1	0.00 0240 7	0.00 6203 3	0.00 4089 6
12/5/2019	0.00 4096 5	0.00 4839 2	0.00 3431 5	0.01 2796 1	0.01 5716 5	0.00 7614 6	0.01 7631 8	0.02 1592 5	0.00 9007 7	0.00 5611 2	0.01 3703 8	0.01 3829 3	0.00 7973 2	0.00 8346 9
12/4/2019	0.00 2402 3	0.00 3954 5	0.00 7573 9	0.00 2473	0.00 5584 9	0.00 256	0.00 2637 6	0.01 2023 5	0.00 3608 9	0.02 1150 2	0.00 0186 7	0.01 0421 2	0.00 2916 9	0.00 0643 7
12/3/2019	0.00 8773 5	0.00 7733 2	0.02 0264 7	- 0.00 3404	0.01 2409 5	0.00 5647 6	0.01 2660 7	0.00 6311 5	0.00 4867 8	0.01 0360 1	0.00 9143 3	0.00 7954 6	0.00 3381 3	0.00 5516 6
12/2/2019	8.07 2E- 05	0.02 1855 9	0.01 2105 3	0.01 1638 8	0.01 6783 8	0.00 1312 5	0.00 7935 7	0.00 1548 1	0.00 7288 9	0.01 4476 4	0.00 8330 6	0.01 3797 4	0.00 4613 8	0.00 7631 7
11/29/2019	0.00 5411 5	0.01 1809 9	0.01 6967 3	0.01 0364 1	0.00 7112	0.00 3310 8	- 0.00 402	0.01 0.01 1661	0.00 6381 9	0.00 5337 6	0.00 7533 2	0.00 3836 1	0.00 5911 1	0.00 9668 6
12/24/2019	0.01 1308 2	0.00 7283 1	0.02 5122 2	0.00 1222 4	0.00 3907 2	0.00 0216 2	0.00 9354 8	0.00 0754 8	0.02 0.02 835	0.01 4715 5	0.00 2126 2	0.00 0718 8	0.01 5270 3	0.00 8958 2
12/18/2019	0.01 3342 3	- 0.00 1263	0.00 0130 2	0.01 4179 5	0.00 2760 2	0.00 7348 8	0.00 6702 6	0.00 0415 7	0.00 2373 1	0.04 2341 2	0.00 0.00 1401	0.00 4897 5	0.00 0370 8	0.00 6216 8
12/17/2019	0.01 9224 7	0.04 6039 8	0.03 1575 8	0.02 8933 8	0.02 3071 3	0.01 6379 6	0.03 7148 3	- 0.03 183	0.02 7804 8	0.03 1662 9	0.02 8761 5	0.03 1767 5	0.03 9927 5	0.03 2914 2
12/6/2021	0.00 6636	0.02 7816	0.00 832	0.00 8353	0.02 3545	0.00 8137	0.01 4799	0.00 728	0.03 5481	0.00 601	0.01 4544	0.01 6816	0.02 2551	0.00 9314
12/3/2021	0.01 868	0.04 527	0.03 502	0.00 089	0.00 8	0.02 441	0.00 3165	0.00 894	0.00 635	0.04 0904	0.01 428	0.00 205	0.01 843	0.00 189
12/2/2021	0.01 476	0.00 3477	0.02 0351	0.00 423	0.00 295	1.59 E-05	0.00 543	0.00 68	0.01 653	0.02 8005	0.00 522	0.00 618	0.00 705	0.00 368
12/1/2021	0.00 651	0.07 232	0.02 2263	0.01 209	0.03 802	0.01 458	0.00 701	0.01 293	0.03 34	0.00 9757	0.02 235	0.03 354	0.02 1422	0.01 027
11/30/2021	0.00 52	0.05 7237	0.05 646	0.02 316	0.00 257	0.00 1135	0.01 541	0.00 253	0.01 502	0.00 4405	0.02 185	0.00 747	0.05 58	0.00 719

11/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/20	0.01	0.02	0.00	0.02	0.01	0.03	0.00	0.00	0.00	0.00	0.01	0.01	0.01	0.00
21	9505	827	193	067	164	18	3123	823	0657	3852	005	661	063	517
11/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
6/20	0.00	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.03	0.00	0.01	0.00	0.00	0.01
21	82	8886	191	2795	5278	364	0788	0626	345	065	6035	6809	9575	2371
12/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/20	0.02	0.01	#NU	0.01	0.04	0.00	0.02	0.02	0.02	0.03	0.02	0.03	#NU	0.02
20	8751	4019	M!	431	164	702	69	2715	2669	531	771	47	M!	061
12/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0/20	0.00	0.01	#DI	0.00	0.03	0.00	0.01	0.00	0.02	0.01	0.02	0.03	#DI	0.01
20	399	448	V/0!	7804	1888	9035	6777	433	4205	5658	392	1433	V/0!	7836
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
5/20	0.00	0.03	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00
23	575	2889	555	179	708	515	679	5654	0302	343	89	724	1256	13
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
4/20	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.01	0.00	0.00	0.01	0.02	0.00	0.00
23	7037	1232	426	9832	2026	8332	6297	0346	306	331	2824	788	295	3164
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
3/20	0.01	0.02	0.00	0.00	0.01	0.00	0.02	0.00	0.01	0.03	0.00	0.02	0.01	0.03
23	5606	733	882	218	788	6865	634	4589	852	5214	8	085	241	588
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2/20	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.01
23	354	8594	4011	494	062	709	619	3039	9275	7094	382	259	2272	059
12/1	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/20	0.00	0.01	0.01	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.01	0.00	0.01
23	499	265	6421	324	5562	26	6514	3452	189	5337	6175	2241	6612	3835
12/8/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2023	0.00	0.00	0.01	0.00	0.00	0.00	0.00	0.01	0.00	0.02	0.00	0.00	0.00	0.00
	616	0336	922	8242	6445	2816	023	242	9076	013	3295	6219	603	0421
12/7/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2023	0.00	0.00	0.01	0.00	0.01	0.01	0.01	0.00	0.01	0.04	0.01	0.01	0.01	0.01
	3436	4277	477	699	118	126	09	15	4951	585	328	597	057	242
12/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0/20	0.00	0.00	0.04	0.01	0.01	0.00	0.03	0.02	0.00	0.01	0.00	0.01	0.05	0.02
22	8415	1172	129	839	5351	468	3662	105	017	333	9288	5923	029	902
12/2	-	-	-	-	-	-	-	-	-	-	-	-	-	-
9/20	0.00	0.00	0.01	0.00	0.00	0.00	0.01	0.00	0.00	0.01	0.00	0.00	0.00	0.00
22	3901	844	6441	065	598	3247	1	2431	4011	328	0909	773	467	812
1/23/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/22/	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	3.87	0.00	0.00	0.00	0.00
2025	047	4661	117	131	291	079	075	1398	0206	E-05	244	176	189	0356
1/21/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	0.00	0.01	0.00	0.01	0.01	0.01	0.01	0.00	0.00	0.01	0.01	0.01	0.00	0.01
	9885	851	108	6454	3122	5889	8638	9529	465	709	7217	3573	4458	4557
1/17/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	0.00	0.02	0.01	0.00	0.00	0.02	0.00	0.02	0.04	0.01	0.00	0.00	0.00	0.02
	4271	411	3072	992	0655	088	9392	023	545	4504	7185	7414	842	4448
1/16/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	0.00	0.02	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
	77	0395	659	1306	235	232	682	2982	779	61	704	5295	437	818
1/15/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	0.00	0.01	0.00	0.01	0.00	0.01	0.00	0.01	0.01	0.01	0.02	0.01	0.00	0.00
	834	008	267	581	261	451	0533	473	6449	6022	46	697	258	784
1/14/	-	-	-	-	-	-	-	-	-	-	-	-	-	-
2025	0.00	0.03	0.02	0.00	0.00	0.00	0.01	0.01	0.01	0.05	0.00	0.00	0.01	8.2E
	4201	6929	128	048	309	4099	181	7544	9495	347	0938	14	328	-05
12/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
1/20	0.00	0.02	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.02	0.01	0.01	0.00	0.01
24	6167	4032	203	5276	843	171	1217	047	4447	7505	242	423	174	411
12/3	-	-	-	-	-	-	-	-	-	-	-	-	-	-
0/20	0.00	0.00	0.00	0.00	0.01	0.00	0.01	0.00	0.00	0.00	0.01	0.01	0.00	0.01
24	435	1222	268	103	577	094	874	964	5474	287	807	855	217	462

Annex C - Standardized Abnormal Returns (SAR)

This appendix presents the standardized abnormal returns used for statistical testing and comparison across firms.

Table 14 - Standardized Abnormal Returns

Date	Standardized abnormal returns - assume cross sectional independence													
	AR* 1	AR* 2	AR* 3	AR* 4	AR* 5	AR* 6	AR* 7	AR* 8	AR* 9	AR* 10	AR* 11	AR* 12	AR* 13	AR*14
12/9/ 2019	0.06 1894	0.05 3747	0.11 2157	0.02 6544	0.01 705	0.04 3865	0.07 2692	0.03 259	0.03 9958	0.06 0762	0.02 0346	0.02 0259	0.02 029	0.0229 88
12/6/ 2019	0.07 1797	0.06 7203	0.06 323	0.00 1198	0.00 3886	0.07 368	0.02 27	0.01 392	0.14 0979	0.02 721	0.06 8549	0.00 229	0.05 2268	0.0472 44
12/5/ 2019	0.04 046	0.04 402	0.02 604	0.13 04	0.14 901	0.08 008	0.15 892	0.18 504	0.07 047	0.04 384	0.12 877	0.13 135	0.06 718	0.0964 2
12/4/ 2019	0.02 3728	0.03 5972	0.05 749	0.02 5201	0.05 2951	0.02 6921	0.02 3773	0.10 3039	0.02 823	0.16 525	0.00 1755	0.09 898	0.02 4577	0.0074 4
12/3/ 2019	0.08 666	0.07 034	0.15 381	0.03 469	0.11 765	0.05 939	0.11 411	0.05 409	0.03 808	0.08 094	0.07 592	0.07 555	0.02 849	0.0637 3
12/2/ 2019	0.00 0797	0.19 8811	0.09 188	0.11 8604	0.15 9128	0.01 3802	0.07 1527	0.01 327	0.05 702	0.11 3105	0.07 8279	0.13 1048	0.03 8875	0.0881 63
11/29/ 2019	0.05 345	0.10 7428	0.12 8781	0.10 5615	0.06 7429	0.03 4817	0.03 623	0.09 9932	0.04 9927	0.04 1703	0.07 0786	0.03 6436	0.04 9806	0.1116 93
11/20/ 2018	0.04 6216	0.17 202	0.30 9963	0.37 0736	0.23 3539	0.04 9107	0.11 2369	0.02 0882	0.03 6138	0.14 4868	0.16 0158	0.31 6222	0.33 455	0.0277 13
11/19/ 2018	0.03 9699	0.52 6252	0.08 7913	0.18 109	0.20 2182	0.03 3287	0.21 4845	0.12 9161	0.02 7789	0.42 2332	0.26 5792	0.08 2346	0.27 7894	0.3936 47
12/6/ 2021	0.08 0615	0.19 3556	0.06 249	0.07 7415	0.17 8977	0.08 3869	0.11 9622	0.06 644	0.27 0924	0.04 604	0.12 6365	0.12 8056	0.17 4936	0.0845 96064
12/3/ 2021	0.22 69	0.31 499	0.26 317	0.00 824	0.06 081	0.25 156	0.02 5585	0.08 163	0.04 85	0.31 3534	0.12 406	0.01 563	0.14 295	0.0171 94716
12/2/ 2021	0.17 934	0.02 4195	0.15 2931	0.03 92	0.02 24	0.00 0163	0.04 39	0.06 207	0.12 625	0.21 4664	0.04 539	0.04 704	0.05 472	0.0333 96356
12/1/ 2021	0.07 913	0.50 323	0.16 7302	0.11 202	0.28 899	0.15 025	0.05 669	0.11 805	0.25 504	0.07 4786	0.19 418	0.25 54	0.16 6171	0.0932 7194
11/30/ 2021	0.06 314	0.39 8277	0.42 429	0.21 467	0.01 956	0.01 1697	0.12 457	0.02 314	0.11 472	0.03 3762	0.18 984	0.05 692	0.43 283	0.0652 80341
11/29/ 2021	0.23 6961	0.19 67	0.01 448	0.19 157	0.08 85	0.32 7776	0.02 5241	0.07 515	0.00 5018	0.02 9525	0.08 733	0.12 651	0.08 243	0.0469 46807
11/26/ 2021	0.09 967	0.13 1414	0.08 953	0.11 8579	0.04 0119	0.03 752	0.08 7204	0.09 7004	0.25 5415	0.00 501	0.13 932	0.05 1851	0.07 4277	0.1123 63196
12/31/ 2020	0.34 9286	0.09 7547	0 0	0.13 265	0.31 649	0.07 231	0.21 742	0.20 7366	0.17 3091	0.27 069	0.24 074	0.26 426	0 0	0.1871 6149
12/30/ 2020	0.04 852	0.10 0756	0 0	0.07 2326	0.24 2398	0.09 3124	0.13 5613	0.03 95	0.18 4825	0.12 0019	0.20 7836	0.23 9371	0 0	0.1620 00537

12/15 /2023	- 0.06 183	- 0.26 4555	- 0.10 338	- 0.01 782	- 0.06 579	- 0.05 706	- 0.05 628	- 0.05 1608	- 0.00 2275	- 0.10 938	- 0.08 041	- 0.06 365	- 0.10 3097	- 0.0110 4
12/14 /2023	0.07 5688	0.00 9912	0.02 83	0.19 795	0.20 4666	0.09 2295	0.05 2165	0.09 4441	0.02 301	0.02 697	0.11 5837	0.24 5073	0.02 705	0.0269 5
12/13 /2023	0.16 7852	0.21 985	0.05 862	0.02 179	0.16 611	0.07 6039	0.21 824	0.04 1892	0.13 949	0.28 6837	0.07 227	0.18 326	0.11 369	0.3056 5
12/12 /2023	- 0.03 807	- 0.14 9567	- 0.09 3161	- 0.04 9308	- 0.00 58	- 0.07 849	- 0.05 128	- 0.11 9023	- 0.06 9851	- 0.13 9238	- 0.03 449	- 0.02 278	- 0.11 24	- 0.0902 4
12/11 /2023	0.05 372	0.10 179	0.10 9182	0.03 233	0.05 1679	0.02 884	0.13 6805	0.03 1511	0.08 951	0.04 3471	0.05 5774	0.10 7608	0.06 0561	0.1178 62
12/8/ 2023	0.06 622	0.00 2701	0.12 778	0.08 2269	0.05 9883	0.03 119	0.00 187	0.11 334	0.06 8358	0.16 396	0.02 9761	0.05 4671	0.05 526	0.0035 9
12/7/ 2023	0.03 696	0.03 44	0.09 818	0.06 976	0.10 391	0.12 4729	0.09 03	0.01 3694	0.11 2603	0.37 346	0.11 992	0.14 042	0.09 679	0.1058 4
12/30 /2022	0.00 588	0.00 318	0.04 2277	0.07 7091	0.07 0219	0.03 7523	0.03 355	0.04 1505	0.03 371	0.01 201	0.02 5157	0.02 7635	0.02 496	0.0179 8
12/29 /2022	0.05 1308	0.08 5348	0.05 121	0.08 537	0.15 585	0.08 2115	0.11 1359	0.06 097	0.16 7513	0.04 0676	0.08 3301	0.07 3584	0.00 7692	0.0843 71
1/23/ 2025														
1/22/ 2025	- 0.00 5	- 0.03 2706	- 0.01 015	- 0.01 197	- 0.02 619	- 0.00 833	- 0.00 672	- 0.00 907	- 0.00 1517	- 0.00 0252	- 0.02 191	- 0.01 436	- 0.01 593	- 0.0032 08
1/21/ 2025	0.10 4298	0.12 9877	0.00 938	0.15 0329	0.11 7995	0.16 7164	0.16 642	0.06 1837	0.03 423	0.11 114	0.15 4704	0.11 0668	0.03 7552	0.1311 74
1/17/ 2025	0.04 5063	0.16 915	0.11 3228	0.09 064	0.00 5892	0.21 968	0.08 3864	0.13 126	0.33 471	0.09 4334	0.06 4559	0.06 0452	0.07 092	0.2203 07
1/16/ 2025	- 0.08 125	- 0.14 3098	- 0.14 375	- 0.10 3295	- 0.02 117	- 0.02 443	- 0.06 085	- 0.01 935	- 0.05 734	- 0.03 9673	- 0.06 322	- 0.04 3172	- 0.03 679	- 0.0736 7
1/15/ 2025	- 0.08 8	- 0.07 073	- 0.02 311	- 0.14 448	- 0.02 343	- 0.15 268	- 0.00 4758	- 0.09 561	- 0.12 1124	- 0.10 4206	- 0.22 109	- 0.13 841	- 0.02 1734	- 0.0706 4
1/14/ 2025	0.04 4327	0.25 9109	0.18 433	0.00 438	0.02 783	0.04 3128	0.10 544	0.11 3844	0.14 355	0.34 7765	0.00 8432	0.01 145	0.11 188	0.0007 4
12/31 /2024	0.06 5069	0.16 8621	0.01 757	0.13 9572	0.07 585	0.01 7994	0.01 0866	0.06 791	0.10 6385	0.17 889	0.11 161	0.11 606	0.01 464	0.1271 8
12/30 /2024	- 0.04 587	- 0.00 8574	- 0.02 319	- 0.00 943	- 0.14 179	- 0.00 989	- 0.16 731	- 0.06 255	- 0.04 0311	- 0.01 8665	- 0.16 233	- 0.15 121	- 0.01 825	- 0.1317 8

Annex D – AAR, CAR, and Statistical Test Results

This appendix contains the AAR, CAR, equally weighted vector of weights, and statistical test results used in the analysis. The calculation methodology is discussed in chapter 4.

Table 15 – AASGITR Comparison from 2015 - 2019

Date	Day	AAR	CAR*	Equally weighted Vector of weights
12/9/2019	3	0.00467	0.571037	0.071428571
12/6/2019	2	0.002203	0.2779342	0.071428571
12/5/2019	1	-0.00964	-1.264326	0.071428571
12/4/2019	0	0.00087	0.1584951	0.071428571
12/3/2019	-1	-0.00846	-1.063457	0.071428571
12/2/2019	-2	0.006251	0.8499718	0.071428571
11/29/2019	-3	0.006462	0.814668	0.071428571
11/28/2019	-4	0.005776	0.7133118	0.071428571
11/27/2019	-5	-0.00245	-0.273107	0.071428571
11/26/2019	-6	0.00022	0.0115242	0.071428571
11/25/2019	-7	-0.00356	-0.464489	0.071428571
11/22/2019	-8	-0.00277	-0.349629	0.071428571
11/21/2019	-9	0.001332	0.1780063	0.071428571
11/20/2019	-10	0.007146	0.8710438	0.071428571
11/19/2019	-11	0.004292	0.5338907	1
11/18/2019	-12	0.0029	0.3296406	14

Table 16 – AASGITR Comparison for 2020-2021

Date	Day	AAR	CAR*	Equally weighted Vector of weights
12/6/2021	3	0.011885	1.343962312	0.071428571
12/3/2021	2	-0.01001	-1.216512465	0.071428571
12/2/2021	1	-0.0015	-0.261757991	0.071428571
12/1/2021	0	-0.01497	-1.697997536	0.071428571
11/30/2021	-1	-0.01071	-1.285221904	0.071428571
11/29/2021	-2	-0.00388	-0.285100371	0.071428571
11/26/2021	-3	0.008014	0.875808893	0.071428571
11/24/2021	-4	0.015095	1.690093998	0.071428571
11/23/2021	-5	0.003251	0.389059022	0.071428571
11/22/2021	-6	-0.01788	-2.124106358	0.071428571
11/19/2021	-7	-0.00504	-0.641053914	0.071428571
11/18/2021	-8	0.021292	2.404714972	0.071428571
11/17/2021	-9	0.008363	0.985347747	0.071428571
11/16/2021	-10	0.005444	0.59266168	0.071428571
11/15/2021	-11	0.00073	0.10838973	1
11/12/2021	-12	-0.01038	-1.164871187	14

11/11/2021	-13	0.010614	1.190465504
11/10/2021	-14	0.005589	0.631280295
11/9/2021	-15	-4.5E-06	-0.052179992
11/8/2021	-16	-0.00572	-0.679054662
11/5/2021	-17	0.004124	0.497634997
11/4/2021	-18	-0.01565	-1.706414603
11/3/2021	-19	0.002884	0.396166803
11/2/2021	-20	0.00871	0.988626363
11/1/2021	-21	0.0066	0.738003243
10/29/2021	-22	-0.01102	-1.228040997
10/28/2021	-23	0.004486	0.584461301

Table 17 - AASGITR comparison for 2022 – 2023

Date	Day	AAR	CAR*	Equally weighted Vector of weights
12/15/2023	3	-0.00163	-0.2051	0.071428571
12/14/2023	2	0.007528	1.009645	0.071428571
12/13/2023	1	-0.00828	-0.92635	0.071428571
12/12/2023	9	0.003913	0.411408	0.071428571
12/11/2023	-1	0.003627	0.408265	0.071428571
12/8/2023	-2	-0.00195	-0.19602	0.071428571
12/7/2023	-3	-0.00761	-0.8762	0.071428571
12/6/2023	-4	0.001071	0.135774	0.071428571
12/5/2023	-5	-0.00811	-1.00038	0.071428571
12/4/2023	-6	0.009265	1.095473	0.071428571
12/1/2023	-7	-0.00146	-0.11027	0.071428571
11/30/2023	-8	-0.00454	-0.46877	0.071428571
11/29/2023	-9	0.001768	0.095206	0.071428571
11/28/2023	-10	0.000198	0.107167	0.071428571
11/27/2023	-11	0.001896	0.215641	1
11/24/2023	-12	-9E-05	0.010757	14
11/22/2023	-13	-0.00564	-0.69819	
11/21/2023	-14	0.004363	0.586049	

Table 18 - AASGITR Comparison for 2024 – 2025

Date	Day	AAR	CAR*	Equally weighted Vector of weights
1/23/2025	3			0.071428571
1/22/2025	2	-0.0003	-0.04987	0.071428571
1/21/2025	1	0.009215	1.177265	0.071428571
1/17/2025	0	-0.00343	-0.32866	0.071428571
1/16/2025	-1	-0.00122	-0.21389	0.071428571
1/15/2025	-2	-0.0059	-0.77636	0.071428571
1/14/2025	-3	0.006089	0.514113	0.071428571
1/13/2025	-4	-0.00412	-0.55436	0.071428571
1/10/2025	-5	0.000113	-0.06736	0.071428571
1/8/2025	-6	-0.01064	-1.05982	0.071428571
1/7/2025	-7	0.005121	0.534396	0.071428571
1/6/2025	-8	-0.01494	-1.7082	0.071428571
1/3/2025	-9	-0.00521	-0.45905	0.071428571
1/2/2025	-10	0.001731	0.148292	0.071428571
12/31/2024	-11	0.001923	0.156583	1
12/30/2024	-12	-0.00693	-0.85605	14
12/27/2024	-13	-0.001	-0.10743	