Master's thesis

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Norwegian University of Science and Technology
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European Energy Markets in Turmoil: Russia's Invasion of Ukraine and its Impact on Stock Prices of European Energy Firms

Master's thesis in Economics and Business Administration
Supervisor: Thomas Lervik
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Abstract

Russia's large-scale invasion of Ukraine in 2022 prompted a ripple effect in global markets, particularly impacting the European energy sector. This study investigates the effect of this geopolitical event on the stock performance of European energy companies, with a nuanced focus on the role of Environmental, Social, and Governance (ESG) ratings and the type of energy production.

To analyze the impact, we conducted an event study, analysing the stock performance of 77 European energy firms through three distinct periods of the crisis. Firms were divided into subgroups based on their ESG ratings and their energy type - renewable or non-renewable.

The results revealed a significant positive impact of the invasion on the firms' stock performance. Additionally, there were significant differences in cumulative average abnormal returns (CAAR) based on firms' ESG scores. Firms with lower ESG ratings showed relatively better stock performance than firms with higher ESG ratings. However no significant difference in the CAAR values between renewable and non-renewable firms was observed.

These findings offer valuable insights into the influence of geopolitical events on energy markets and the potential protective role of strong ESG ratings during periods of geopolitical instability. This research adds to the growing body of evidence on the role of ESG in investment and the shifting dynamics of the energy sector. Future research should continue to explore these themes, particularly in light of ongoing geopolitical uncertainties and the global drive towards sustainable energy sources.

Sammendrag

Russlands invasjon av Ukraina i 2022 utløste sjokkbølger gjennom globale markeder, som spesielt påvirket den europeiske energisektoren. Denne studien undersøker effekten av denne geopolitiske hendelsen på aksjeprestasjonen til europeiske energiselskaper, med et nyansert fokus på rollen til Environmental, Social, and Governance (ESG) rangeringer og type energiproduksjon.

For å analysere innvirkningen, gjennomførte vi en hendelsesstudie som analyserte aksjeprestasjonen til 77 europeiske energiselskaper gjennom tre distinkte perioder av krisen. Selskaper ble delt inn i undergrupper basert på deres ESG-rangeringer og deres energitype - fornybar eller ikke-fornybar.

Resultatene avdekket en betydelig positiv effekt av invasjonen på selskapenes aksjeprestasjoner. I tillegg var det betydelige forskjeller i kumulative gjennomsnittlige unormale avkastninger (CAAR) basert på selskapenes ESG-rangering. Selskaper med lavere ESG-rangering viste til relativt bedre aksjeprestasjoner enn selskaper med høyere ESG-rangering. Det ble imidlertid ikke observert noen betydelig forskjell i CAAR-verdiene mellom fornybare og ikke-fornybare selskaper.

Disse funnene tilbyr verdifull innsikt i påvirkningen av geopolitiske hendelser på energimarkeder og den potensielle beskyttende rollen til ESG rangeringer i perioder med geopolitisk ustabilitet. Denne forskningen bidrar til den voksende mengden av kunnskap knyttet til ESG sin rolle i investeringer og de skiftende dynamikkene i energisektoren. Fremtidig forskning bør fortsette å utforske disse temaene, spesielt i lys av pågående geopolitiske usikkerheter og den globale drivet mot bærekraftige energikilder.

Preface

This is a master thesis developed as the final evaluation of the master's program *Economics and Business Administration* at NTNU Business School. This endeavor marks a significant milestone in the intellectual advancement I've experienced over my two-year course of study at this respected institution. The freedom to choose a topic that genuinely piqued my interest led me to delve into the intriguing sphere of geopolitics, ESG investing, and the energy sector. The unfolding scenario of the Russian invasion of Ukraine and its ensuing impact on European energy companies offered a compelling context for my exploration. Working on this project under the guidance of my supervisor, Thomas Lervik, has been a rewarding and enlightening experience. His valuable insights have been of great assistance. Completing this thesis has been a challenging yet fulfilling process, and I hope that it contributes valuable insights to the existing body of literature on the topic. It is my hope that this study will ignite discussions and inspire further research in this important field. Lastly, I would like to express my deep gratitude to the faculty and staff at NTNU for their unwavering support throughout my academic journey, and for providing a nurturing environment for me to grow and learn. It has truly been a privilege.

25nd May 2023, Trondheim

Håvard Hartgen Nordås

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1 INTRODUCTION

The world awoke to a geopolitical shift on February 24, 2022, when Russia launched a large-scale invasion of Ukraine, sending ripples of uncertainty through global markets. Reports of attacks by Russian forces emerged from major cities across the country, marking a turning point in global geopolitics. This event, and its immediate aftermath, form the epicenter of the present study.

In the context of global trade and energy, Europe's intricate connection with Russia is critical. As of 2021, the European Union imported more than 40% of its total gas consumption, 27% of oil imports, and 46% of coal imports from Russia, with energy accounting for 62% of the EU's total imports from Russia at a cost of €99 billion (European Commission, 2022). Consequently, a conflict of this magnitude, located in Europe's primary energy supplier, was bound to send shockwaves through the European energy industry. The invasion triggered a sequence of events that reshaped the global landscape by disrupting energy supplies and altering trade dynamics between countries. These changes were further intensified by a series of sanctions, capital controls, and asset freezing enacted in response to the invasion (European Council, 2023b). The oil price saw a significant surge, increasing by 30% within two weeks following the invasion, adding further pressure to an already strained industry (BBC, 2022).

Our study plunges into this turbulent environment, aiming to examine the impact of the invasion on European energy firms. The focus is not solely on the immediate effects but also on the time period surrounding the event, more specific capturing the market response in three distinct periods: The Build-up period (January 24 – February 21), the Outbreak period (February 22 – March 8), and the Continuation period (March 9th – April 6th).

In the face of significant market disturbances such as the Russian invasion of Ukraine, the reactions of investors and firms are shaped by a large number of different factors. Among these, the aspect of Environmental, Social, and Governance (ESG) characteristics, ESG has gained substantial attention in recent years. The surge in interest towards socially responsible investments over the past decade is undeniable. Internet searches for the term "ESG" have increased fivefold since 2019, in addition does more than 90% of S&P 500 companies have published ESG reports in some form, suggesting a growing recognition of ESG and its financial relevance (Perez et al., 2022). Moreover, we extend our scope to understand whether the firm's ESG characteristics and the type of energy they produce (renewable vs. non-renewable) played a role in their stock performance during these critical periods. We build upon the findings of Lööf et al. (2021), which suggest that superior ESG ratings are associated with lower downside risk and lower upside return potential.

We live in a world with interconnected global economies and volatile geopolitical climates, research on market reactions to geopolitical events like the Russian invasion of Ukraine is of great relevance. The significance of this research becomes particularly important considering the energy sector's strategic role in the global economic framework and its natural vulnerability to geopolitical shifts. The invasion of Ukraine underscored this point, as energy supplies, trade, and geopolitics experienced major change, underlining the importance of our study. Moreover, the European Union's substantial dependence on Russia for its energy imports establishes a direct link between the actions in Ukraine and the performance of European energy firms. With energy imports from Russia constituting a significant portion of the EU's total imports, the repercussions of the geopolitical event reach far and wide within the European energy sector.

The relevance of this study is also underscored by the increasing attention to the concept of ESG investing. As businesses and investors strive to align economic activity with sustainable and ethical principles, understanding the impact of ESG ratings on stock performance during crises becomes essential. For that reason, our findings could offer valuable insights into effective risk management during periods of instability. Finally, the study's focus on the disparity between renewable and non-renewable energy firms brings attention to an important aspect in the ongoing energy transition. How these two factions within the energy sector respond to the same crisis could offer critical cues for policymaking, investment decisions, and strategic planning.

1.1 Research Problem

In this study, we aim to explore and better understand the impact of the Russian invasion of Ukraine on the performance of European energy companies' stocks. Our main research question is:

1. ***Did the Russian invasion of Ukraine have a significant impact on the stock performance of European energy companies?***

In addition to our main research question, we included two sub-questions:

2. *Did the impact on stock price differ between firms with high (ESG) scores and those with low ESG scores during the build-up, outbreak, and continuation periods of the Russian invasion?*
3. *Did the impact on stock price differ between renewable and non-renewable energy firms during the build-up, outbreak, and continuation periods of the Russian invasion?*

To approach these questions, we formulated three null hypotheses as a starting point for our research:

(H0): *The CAAR of European energy companies is not significantly different from zero during the Russian invasion of Ukraine.*

(H01): *There is no significant difference in the CAAR between firms with high ESG and low ESG scores during the build-up, outbreak, and continuation periods of the Russian invasion of Ukraine.*

(H02): *There is no significant difference in the CAAR between renewable and non-renewable energy firms during the build-up, outbreak, and continuation periods of the Russian invasion of Ukraine.*

To adequately test these hypotheses and formulate an answer to our research questions, we utilized the Event Study methodology. This approach will allow us to measure the financial impact of an event on a company's stock price, providing a clearer understanding of the implications of the geopolitical event on the European energy sector.

1.2 Historical Context of the Russia-Ukraine Conflict.

To examine the influence of the Russian-Ukrainian war on the financial markets, it is necessary to have a brief understanding of the historical context and key moments leading up to the event, and during the event itself. The conflict has affected energy supplies, trade, and geopolitics, along with a series of sanctions, capital controls, and asset freezes (European Council, 2023). This subchapter seeks to present a brief timeline of the Russian-Ukrainian conflict, shredding light on the relationship between Russia and Ukraine, the underlying causes of the dispute, key turning points, and its influence on financial markets. The timeline will delve deeper into key events occurring early 2022, more specifically during the event windows of our event study. We have labeled these event windows as The *Build-up* period (24th Jan - 21st Feb), *Outbreak* period (22nd Feb - 8th Mar), and *Continuation* period (9th Mar - 6th Apr). A more comprehensive presentation of relevant events during these periods is provided to create a clear understanding of the rationale behind the chosen timeframes for our event study. In addition, a clear presentation of key incidents during the event windows will allow for a possible explanation to abnormal returns observed during the event windows.

Before the invasion in 2022, the relationship between Russia and Ukraine had a complex history characterized by deep cultural, linguistic, and political ties, as well as periods of tension and conflict. Following the dissolution of the Soviet Union in 1991, Ukraine gained independence and began forging its path as a sovereign nation. However, the two countries shared history and the presence of a significant Russian-speaking population in Ukraine made their relationship challenging. Putin has criticized NATO for expanding eastward since the fall of the Soviet Union in 1991. He has said NATO enlisting nations on Russia's borders represents a provocation, though NATO insists it is a defensive alliance and not a threat to Russia (Vlamis, 2022). In 2008, Ukraine filed their application for NATO membership, which further tensed the two nations relationship. This application has not yet been accepted or withdrawn (Interfax, 2022).

Ukraine's strategic importance to Russia is another factor in their challenging relationship. Ukraine contains the worlds largest natural gas transit infrastructure (Sankar, 2022). The European Union receives about 40% of its natural gas from Russian pipelines, and about a quarter of that flows trough Ukraine (Baldwin, 2022). Russia's annexation of Crimea in 2014 marked a significant turning point in their relationship, as it led to increased tensions and the ongoing conflict in eastern Ukraine. The war in the Donbas region pitted Ukrainian government forces against Russian-backed separatists, further straining diplomatic ties and escalating hostilities (Ray, 2023).

Tensions later escalated in spring 2021 when Russia began massing troops near Ukraine's borders, claiming they were conducting training exercises. The build up of Russian troops continued throughout 2021. In November 2021, Satellite images taken by Maxar Technologies showed a buildup of Russian forces of near 100.000 troops (Reuters, 2022). In December 2021, U.S. President Biden met virtually with Russian President Putin (Borger & Roth, 2021). Later, Emmanuel Macron also Putin in an effort to defuse tensions (Bashir et al., 2022). Despite the diplomatic effort, Russia showed no signs of de-escalating.

1.2.1 The Build-up period (January 24 – February 21)

The lower bound of our first event Window is set on January 24, 2022. On this day NATO put troops on standby and sent ships and fighter jets to bolster Europe's eastern defenses (NATO, 2022). The following day, January 25, Moscow initiated military exercises involving approximately 6,000 troops and at least 60 fighter jets in southern Russia near Ukraine and in Moscow-annexed Crimea (Themoscowtimes, 2022). On February 2, 2022, the United States sent 3,000 troops to fortify NATO forces in eastern Europe (Bertrand et al., 2022). February 10, Russia and Belarus began extensive military drills in Belarus. The military drills lasted for 10 days and added to the concerns over a possible invasion of Ukraine (Hodge et al., 2022). On February 17, 2022, shellfire intensified along the frontline of the Russian backed regions Donetsk and Luhansk in eastern Ukraine. The leaders of the Donetsk and Lugansk separatist regions announced they were evacuating residents to Russia.

February 21, 2022, marks the upper bound of the Build-up event window, on this date Putin recognized the independence of Donetsk and Luhansk in eastern Ukraine and ordered Russian troops into both areas on a "peacekeeping" mission (BBC, 2022). The move further escalated fear among Western nations about a Russian invasion of Ukraine.

1.2.2 The Outbreak period (February 22 – March 8)

23. February US authorities estimated more than 150,000 Russian troops along the Ukrainian border. The same day Ukraine announces a nationwide state of emergency (Mayberry et al., 2022). February 23 also marks the day EU impose the first package of sanctions against Russia, In response to their increasing aggression. This includes sanctions against 351 Russian Parliament members, as well as restrictions of Russia's access to EUs capital and financial markets (European Council, 2023a). The same day President Biden allowed sanctions to move ahead against the company that built Nord Stream 2 (Mayberry et al., 2022).

February 24, 2022. This marks the day Russia initiated a large-scale invasion of Ukraine, with reports of attacks by Russian forces emerging from several major cities across the country (*Statista*, 2023).

On February 27, 2022, European Commission chief Ursula von der Leyen announced that Russian aircraft would be banned from EU airspace, and Russian state-owned media Russia Today, Sputnik and their subsidiaries would be banned from EU airwaves and the internet. The EU also stated it would ban selected Russian banks from the SWIFT interbank transaction system, essentially cutting them off from the global financial system (European Council, 2022). Further sanctions were imposed by the EU on February 25th, 28th, and March 2nd. These dates marked the implementation of EUs second, third, and fourth packages of sanctions respectively.

Due to the ramifications of the Russian invasion and subsequent sanctions, the value of the Russian ruble dramatically dropped from $0.012 on February 25 to $0.007 by March 11. Unlike the ruble, which suffered a significant blow during the outbreak period, Brent Crude oil experienced a dramatic increase in price. From February 24 to March 8, the cost of oil jumped from $95 to $129 per barrel. While the price has subsequently fallen, the sharp initial rise could potentially illustrate market expectations of the consequences of the Russian invasion and subsequent sanctions on the energy market. This price volatility underscores the potential impact of geopolitical events on commodity prices.

March 8 marks the end of the outbreak period in our analysis, on this day the United States banned import of Russian oil, gas and coal (U.S. Ebassy, 2022).

1.2.3 The Continuation period (March 9th – April 6th)

The continuation period entails further military confrontations between Russia and Ukraine, along with additional sanctions targeting Russia.

15. March EU implemented their fourth package of sanctions in response to Russia's invasion of Ukraine.

Following the substantial surge of the oil price during the Outbreak period, the oil price saw a considerable reduction during our Continuation period, with brent crude oil declining from $129 to $102 per barrel (Market Insider, 2023). This change occurred from March 8, the final day of the Outbreak period, to April 6, the last day of the Continuation period.

2 THEORY

2.1 INTRODUCTION

This chapter introduces key theories relevant to our study. The chapter contains a brief explanation of the Efficient Market Hypothesis, and its relevance in event studies, and delves into the concept of ESG investing.

2.2 THE EFFICIENT MARKET HYPOTHESIS

The Efficient Market Hypothesis posits that the current price of an asset is a comprehensive reflection of all accessible information. The premise of the hypothesis is that changes in asset prices occur solely in response to the emergence of new information. Given the inherent unpredictability of new information, price changes should, according to the hypothesis, be equally unpredictable, implying a random evolution of asset prices. Consequently, the hypothesis suggests that no investor could gain a consistent advantage by attempting to predict stock performance.

Eugene Fama, proposed three levels of market efficiency, each one depending on the kind of information that is factored into the prices of assets. These forms are known as: weak, semi-strong, and strong. The weak form suggests that past stock prices and trading volume cannot be used to predict future stock prices, as they are already reflected in current prices. The semi-strong form posits that stock prices not only reflect historical data but also quickly adjust to new publicly available information. The strong form asserts that stock prices incorporate all information, both public and private, leaving no room for consistent abnormal returns through trading.

If the market is efficient, the efficient market hypothesis suggests that market prices will adjust instantly to new information, leaving no room for further increases or decreases in prices. However, previous research have uncovered instances of price movements that deviate from this concept.

Research by De Bondt and Thaler (1990) suggested that markets have a tendency to overreact to new information. This overreaction can lead to drastic swings in prices, surpassing their intrinsic value before eventually stabilizing back to an equilibrium price. In another study, Bernard and

Thomas (1989) discovered a phenomenon of delayed market reaction, whereby prices do not immediately react in full to new information.

2.2.1 The Efficient Market Hypothesis in Event studies

At the core of event study methodology lies the Efficient Market Hypothesis, as proposed by Fama (1970). Since the stock price reflects all current available information, further price change must be a reflection of new information. Hence, an event study enables one to assess the impact of an unanticipated event on a firms stock price changes during the period in which the event occurs, and further test whether the market incorporates this new information efficiently. Therefore, event studies can be seen as a way to empirically test the validity of the Efficient Market Hypothesis. Fama (1991) emphasizes that event studies are the cleanest evidence supporting market efficiency.

The Efficient Market Hypothesis is of great importance for investors seeking mispriced securities. If current prices indeed reflect all available information, attempts to outperform the market would simply rely on luck. Therefore, understanding the level of informational efficiency within financial markets is of great relevance to investors and other participants within the market.

The presence of market efficiency is a critical precondition for evaluating the impact of a specific event. In an efficient market, any new information would instigate a change in a firm's value. Consequently, an event study allows for the identification of elements influencing eighter individual stock prices or the overall market.

2.3 ESG

The ESG framework further builds on concepts of corporate social responsibility (CSR), social responsible investing (SRI) and responsible investing (RI). The term "ESG" first gained prominence in the mainstream discourse through a 2004 report titled “Who Cares Wins” by the United Nations titled “Who Cares Wins” (2004). However, an important difference from the former measures of sustainable investing is that ESG investing is based on the assumption that ESG factors have financial relevance. Therefore, the rationale behind integrating ESG factors into an investment strategy extends beyond ethical and moral considerations, as it also carries implications for potential returns. ESG is an acronym for Environmental, Social, and Governance, it represents a comprehensive approach that assists stakeholders in understanding how an organization navigates risks and opportunities related to these pivotal areas. The framework is grounded in three fundamental dimensions, each comprising different measurable factors.

Firstly, the environmental dimension includes data on factors including climate change, greenhouse gas emissions, loss of biodiversity, deforestation/reforestation, pollution mitigation, energy efficiency, and water management. These components shed light on a firm's environmental footprint and its efforts to mitigate adverse ecological impacts.

The second dimension, the social aspect, encompasses data on employee safety and health, working conditions, diversity, equity, and inclusion. It also considers the company's responses to conflicts and humanitarian crises. These social factors are vital for evaluating risk and return as they directly impact customer satisfaction and employee engagement, which can significantly enhance or undermine a company's reputation and performance.

Lastly, the governance dimension comprises data on aspects of corporate governance such as anti-bribery and anti-corruption measures, diversity within the Board of Directors, executive compensation, cybersecurity and privacy practices, and the overall management structure. These factors provide insights into the ethical integrity, leadership quality, and accountability standards within an organization.

A more detailed exploration of ESG-investing and its role in financial performance and risk management is presented in the literature review.

2.4 ESG IN THE LIGHT OF ORGANIZATIONAL THEORIES

The effect of ESG factors on firm value and risk can be debated in context of organizational theories. In light of the stakeholders theory by Freeman (2015), incorporating ESG into a firms decision making process should have a positive effect on firm value and risk management. According to the stakeholders theory companies should consider the interest of all stakeholders, including employees, customers, suppliers, communities, and shareholders. Incorporating ESG in a firm’s strategy, may lead to improved reputation, increased trust and create a stronger relationship with stakeholders. As a result, firms could benefit from better risk management, and enhanced long term value creation.

Similarly, in the light of the risk management theory (Godfrey, 2005), incorporating ESG factors should also have a positive effect on firm value and risk management. This theory emphasizes that companies need to identify, assess, and manage various risks to ensure their long-term survival and success. ESG factors play a role in managing risks, as they cover environmental, social, and governance aspects that can influence a company's operations and reputation. By addressing ESG concerns, companies can reduce their exposure to potential risks, such as government environmental regulations, reputational damage, and operational disruptions due to ethical and legal management (Segund, 2021), (Riskoptics, 2021).

On the other hand, in the light of the theory of managerial opportunism, ESG integration might have a negative effect on a firm's value or risk. The theory suggests that that managers might exploit opportunities in his own self interest (Wright, 2019). There is room to argue that managers might have a personal interest in overinvesting in ESG, if doing so provides benefits of reputation building. On the other hand, managers who are motivated by short-term profits might underinvest in ESG, thereby disregarding risks that may occur in the long run.

3 LITERATURE REVIEW

3.1 INTRODUCTION

This literature review explores two key topics: the impact of the Russia-Ukraine conflict on global financial markets, and the role of ESG factors in risk management and financial performance. This chapter aims to synthesize diverse research findings to offer a coherent understanding of these topics.

3.2 THE RUSSIAN-UKRAINE WAR AND ITS IMPACT ON FINANCIAL MARKETS

A study by Boungou et. al. (2022) investigates the impact of the Ukraine-Russia war on global stock market returns. Utilizing daily stock market returns from a diverse sample of 94 countries, spanning from January 22, 2022, to March 24, 2022. The researchers consistently identified a negative relationship between the conflict and worldwide stock market returns. The results indicate a more significant effect at the onset of the war, particularly during the initial two weeks following the invasion of Ukraine. Followed by a diminished reaction in the subsequent weeks. Additionally, the study highlights that these effects were most pronounced in countries bordering Ukraine and Russia, as well as in those United Nations member states that demanded an end to the Russian offensive in Ukraine.

Furthermore, the paper "Global Economic Consequence of Russian Invasion of Ukraine," by Ozili (2022) examines the worldwide economic repercussions of the Russian-Ukraine conflict during the month of the invasion. The invasion led to numerous international sanctions against Russia with the aim of forcing de-escalation. Although these sanctions targeted Russia, they produced spillover effects on the global economy, primarily through disruptions to the global supply chain. To further analyze these consequences, the study by Ozili utilizes global data, as well as data from the Euro Area, Ukraine, and Russia. The findings revealed an increase in the global Purchasing Managers' Index (PMI) and a surge in the global food prices. Additionally, the index of global stock markets experienced a sharp decline on the day of the invasion, this is consistent with the findings of Boungou et. al. (2022).

Another relevant paper by Ahmed et. al. (2022) conducted a study to examine the impact of the Russia-Ukraine crisis on the European stock market. The researchers utilized the event study methodology and utilized firms belonging to the STOXX Europe 600 index in their sample. Their findings indicate that European stocks experienced a significant negative abnormal return when Russia recognized two Ukrainian states as autonomous regions on February 21, 2022. This negative stock price reaction persisted in the post-event period. Providing robust evidence for the detrimental impact of the Russia-Ukraine crisis on the European stock market. The study reveals negative abnormal stock returns in Europe which is consistent with research by Boungou et. al. (2022) and Ozili (2022), demonstrating a correspondence between the findings despite the difference in geographic focus.

The paper by Ahmed et. al. (2022) also examining industry-level variation, observing significant differences in AAR and CAR surrounding the event period. Despite the overall negative market reaction reaching its lowest point during the longer post-event window, the energy sector experienced a positive, although non-significant on the event date, followed by a positive CAR during the extended post-event window. Although the energy sector deviating from the overall market reaction, Ahmed et. al. (2022) express little surprise, attributing this to energy firms reaping the benefits of rising oil and gas prices in the aftermath of Russia's invasion of Ukraine. The paper concludes by highlighting the need for European policymakers to reconsider their substantial reliance on Russian oil and gas supplies and to explore alternative energy sources while working towards long-term sustainability. Emphasizing the importance of prioritizing the growth of renewable energy.

In a paper by Bao et. al. (2022) the researchers aimed at examining the impact of the Russian-Ukraine war specifically on the European energy firms stock prices, using the UK stock market as an example. The researchers utilized linear regression models to investigate the associations between different factors. Their findings indicate that the positive correlation between Brent crude oil yield and the excess return of energy stocks strengthened both before and after the Russia-Ukraine war. At the same time, there was a decline in the positive correlation between the excess return of the market portfolio and the excess return of energy stocks.

Another interesting paper analyzed the impact of the Russian-Ukraine war on stocks related to the transition to a low-carbon economy. The results showed that stocks more exposed to regulatory risk associated with the low-carbon transition performed better, indicating that investors expect a slowdown in the transition. However, the effects were more pronounced in the US than in Europe, in Europe the effects were less significant or even opposite. Indicating that the market initially anticipated stronger policy response in Europe to support energy from renewable sources (Deng et al., 2022).

Although there are a handful of studies examining the consequences of the Russia-Ukraine war on both the global and European economy, there remains a scarcity of research examining the specific effects of the conflict on European energy companies stock prices. More specifically, there is a lack in research on the differences in stock return based on these firms’ ESG scores or the differences in impact between renewable and non-renewable energy companies. Consequently, our study aims to broaden the existing literature in this area and encourage further research.

3.2.1 The role of ESG in risk management and financial performance

Over the past decade, the interest in socially responsible investments has grown exponentially. Only since 2019 internet searches for the term ESG have five folded (Perez et al., 2022). According to a 2018 global survey by FTSE Russell, more than half of asset owners are currently considering or already implementing ESG consideration in their investment strategy (FTSE Russell, 2018). The availability of non-financial data, including corporate social responsibility or environmental, social, and governance data, has skyrocketed and gained interest from investors for various reasons.

According to Perez et al (2022) more than 90% of S&P 500 companies have published ESG reports in some form. When using ESG scores it is important to be aware of the methodical process that determines the score. There are over 59 ESG rating providers currently active in EU (Berrigan, 2022). Results from a research conducted by Zumente & Lāce (2021) indicate significant divergence in the ratings awarded to European companies from different ESG providers, thus the researcher suggests investors to pay attention to the methodologies and practices used by different agencies used to calculate ESG ratings.

A Paper by Shafer & Szado (2018) found trough their study on ESG practices on perceived Tail risk, that better ESG practices, significantly reduce the perceived tail risk in individual equity securities. Suggesting that investor's view ESG as a form of insurance against negative events.

This is also in line with De & Clayman (2015) who trough their research on the relationship between companies ESG score, stock returns, volatility and risk-adjusted returns in the post 2008 financial crisis period. Found a negative correlation between ESG rating and stock volatility, and that this relationship was stronger when market volatility was higher. Results from this research also indicated that low ESG rated stocks tended to be in the high volatility group, while high ESG stocks tended to be in the low volatility group.

A comprehensive meta-analysis, combining findings from about 2200 individual studies examining the relationship between ESG and financial performance. Found that about 90% of the existing studies in the field reported a non-negative relationship between ESG and financial performance. As well as the majority of findings indicating a positive relationship between ESG and financial performance, these results also appeared stable over time, and across various categories and regions (Friede et al., 2015).

In contrast a study by Breedt et al. (2018) found that incorporating ESG rating as well as the individual ESG pillars into a neutral worldwide equity market portfolio yields no additional return, nor higher risk-adjusted returns. Their study indicated that benefits from incorporating ESG into a portfolio are already captured by other equity factors. The study also suggests that data quality issues, and the lack of a common framework for ESG providers are barriers for ESG investment strategies (Breedt et al., 2018).

A research conducted by Lööf et al. (2021) examined the impact of Corporate Social Responsibility investing during COVID-19, by utilizing data from 5,073 stocks listed on 10 stock markets. The results indicated that better ESG ratings are linked to lower downside risk and lower upside return potential. In essence, ESG ratings helped investors mitigate their risk exposure during the market turmoil caused by the pandemic, while the fundamental trade-off between risk and reward remained intact.

While the literature seems to indicate a correlation between ESG and risk management, the question of causality seems to be inadequately addressed in the literature. The inconclusive results highlight the need for further research, as well as a improvement in the consistency of data and framework utilized by ESG providers.

4 METHODOLOGY

4.1 INTRODUCTION

In this chapter, we introduce the event study methodology, which is used to investigate the impact of the Russian invasion of Ukraine on the stock prices of European energy firms. The primary objective of our research is to evaluate the impact of this event on five distinct portfolios: All_firms, High_ESG, Low_ESG, Renewable, and Non-renewable.

Utilizing the event study methodology, we will analyze the abnormal returns (AR) for each portfolio in tree separate event windows: build-up, outbreak, and continuation period. In addition, we will conduct statistical tests to determine if there are significant differences in the events impact across the various portfolios. Furthermore, this chapter provides a description of the empirical methodology applied in this study.

4.2 EVENT STUDY METHODOLOGY

The event study methodology is a widely used research technique in finance (Peterson, 1989). The event study is based on the efficient market hypothesis, that states that the stock price reflects all current available information, for that reason further price change must be a reflection of new information (Fama, 1970). By examining stock price movements around the event date, we can estimate the event's effect on the market's perception of the company's value.

4.2.1 Event Date, Event Window and Estimation Window

The procedure begins with defining the event date, the event window and the estimation window. The event date (t = 0) represents the point at which the market becomes aware of the relevant new information. A precise specification of the event date is essential for accurately measuring the event's impact. The event window encompasses the time period in which the stock prices are analyzed. MacKinlay, (1997) notes that it is common to define an event window that starts prior to and extends to a period after the event of interest. This approach enables researchers to capture information acquired by market participants before the announcement as well as identify whether the price response is quick or delayed.

The estimation window is the time frame during which the parameters of the chosen normal return model are determined. The most common choice when determining the estimation window is to choose a period prior to the event window (MacKinlay, 1997). MacKinlay also points out the importance of avoiding overlap between the estimation window and the event window, this is to prevent the event from influencing the parameter in which the normal performance is estimated on. There is no predetermined length of the estimation window. Longer estimation windows offer increased accuracy due to a larger sample of returns, but risks including cofounding event that might affect the normal performance model. According to (Krivin et al., 2003) an estimation window of 60 days to one year is considered to be an appropriate length for the estimation window, as this ensures sufficient data to estimate the normal performance model, while minimizing the risk of including time periods characterized by different market dynamics in addition to cofounding events.

4.3 ESTIMATING NORMAL PERFORMANCE (FAMA FRENCH 3-FACTOR MODEL)

The next step in the event study is to select an expected returns model and estimate normal performance. This is a crucial step, as it allows us to determine the expected returns of the stocks in our sample in the theoretical absence of the event. This step is necessary for calculating Abnormal Returns (AR) during the event window.

To estimate normal performance, we use the Fama-French 3-factor model. The Fama-French 3-factor model build upon the Capital asset pricing model, by including two additional factors: the size factor (SMB) and the value factor (HML). By incorporating the SMB and HML factors, the model adjust for the fact that value and small-cap stocks outperforms the market on a regular basis (Fama & French, 1992). The formula for our normal performance model (Fama-French 3-factor model) is shown in equation (1).

$$E\left(R_{i,t}\middle|X_t\right) = Rf_t + \beta 1_i(MKT_t - Rf_t) + \beta 2_i(SMB_t) + \beta 3_i(HML_t) + Alpha_i \tag{1}$$

Where:

$E(R_{i,t}|X_t)$ Represents expected return of the stock or portfolio *i* at time *t*, given the condition information for the Fama french 3 factor model X.

Rf_t Is the risk-free rate.

$Alpha_i$ Is a constant term representing the stock or portfolio's excess return not explained by the three factors.

MKT_t Represents the market return.

SMB_t (Small Minus Big) is the size factor, representing the excess return of small-cap stocks over large-cap stocks.

HML_t (High Minus Low) is the value factor, representing the excess return of value stocks (high book-to-market ratio) over growth stocks (low book-to-market ratio).

$B1_i$	Is the sensitivity of the stock or portfolio to the market factor
$B2_i$	Is the sensitivity of the stock or portfolio to the size factor
$B3_i$	Is the sensitivity of the stock or portfolio to the value factor

4.4 CALCULATION OF ABNORMAL RETURNS

In order to evaluate the impact of the event, a measure of the abnormal return (AR) is required. The AR is the actual return of a security during the event window, minus the normal return of the security over the same period.

For firm *i* and event date *t*, the formula for AR is expressed in equation (2):

$$AR_{i,t} = R_{i,t} - E\left(R_{i,t} \middle| X_t\right) \tag{2}$$

Where:

$AR_{i,t}$	Is the abnormal return
$R_{i,t}$	Is the actual return
$E(R_{i,t}\|X_t)$	Is defined as shown in equation (1)

We proceed to compute the cumulative abnormal return (CAR) by aggregating the ARs during the event window, from t_1 to t_2, where $t_1 < t_2$ and t_1 , t_2 is the event window.

For firm i and event date t, the CAR is defined by:

$$CAR_1(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{i,t} \tag{3}$$

In our study, we aim to investigate the impact of a specific event on a group of firms. Kothari and Warner (2007) suggest that aggregating ARs across a cross-section of firms is beneficial when the goal is to analyze the average impact of an event on the wealth of security holders, or to test economic models and alternative hypotheses regarding the direction of the event's average effect (Kothari & Warner, 2004). Cross-sectional aggregation can be done by calculating the Average Abnormal Return (AAR) for the selected pool of companies. The AAR allows us to measure the average impact of the event on the stock returns across the group on a single specific day. The formula for AAR is expressed in equation (4):

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} AR_{i,t} \tag{4}$$

When examining the average effect spanning multiple days as we do in our analysis, it is essential to conduct both types of aggregations mentioned earlier and calculate the cumulative average abnormal returns (CAAR) by summing the average abnormal returns over time, as demonstrated in equation (5):

$$CAAR(t_1, t_2) = \sum_{t=t_1}^{t_2} AAR_t \tag{5}$$

4.5 TESTING THE SIGNIFICANCE OF THE ARS

Event studies aim to determine if AR within an event window are significantly large. To test whether the AR is are significant a formal hypothesis test is conducted. The null hypothesis states that the expected value of a specific random variable is zero. If the null hypothesis is rejected, it suggests that the event had a notable effect. In line with standard practice in event studies, two-sided tests are utilized (eventstudytools, 2023). With a two-sided test the alternative hypothesis state that the expected value is significantly different from zero, rather than being exclusively larger or smaller than zero.

The one sample T-test and Corrado test where used to determine whether the AAR and CAAR during the event windows where statistically different from zero. Consequently, the two null hypothesis of interest can be expressed as : $E(AAR_0) = 0$, $E(CAAR_0) = 0$

To account for the dependence across firms average residuals, in event time, Brown & Warner (1980) suggest that the standard deviation of average residuals should be estimated from the time series of the AARs over the estimation period. This method is called the "Crude Dependence Adjustment". To address the null hypothesis $E(AAR_0) = 0$ the test statistic for the crude adjusted t-test is given by equation (6). To address the second null hypothesis $E(CAAR_0) = 0$, the same formula is used, with the exception of the AAR value, which needs to be replaced with the CAAR value.

$$T = \sqrt{N}\frac{AAR_{i,t}}{S_{ARR_{i,t}}} \tag{6}$$

Where S^2_{ARR} is expressed in equation (7).

$$S^2_{ARR} = \frac{1}{M-1}\sum_{t=T_0}^{T_1}\left(AAR_t - \frac{1}{M}\sum_{t=T_0}^{T_1}\mathrm{AAR_t}\right)^2 \tag{7}$$

Where:

T Is the t-test statistic.

AAR Is the average abnormal return during the event window.

M Is the number of non-missing AAR values during the estimation window.

N Is the number of observations.

In addition to the crude adjusted t-test, the Corrado Rank test is included to test the statistical significance of the average abnormal returns during the event windows (Corrado, 1989). In contrast to the t-test, the Corrado Rank test is a non-parametric test. The rank test does not require symmetry of the cross-sectional abnormal return distribution.

The formula for the Corrado rank test statistic, with null hypothesis of interest $E(AAR_0) = 0$ is expressed by equation (8).

$$Z = \frac{\overline{K_0} - 0.5}{S_{\bar{k}}} \qquad (8)$$

In order to implement this test, it is first necessary to transform each firm's abnormal returns into their respective ranks, and then compute a vector of scaled ranks based on the combined sample. The formula for the vector of scaled ranks is expressed in equation (9).

$$K_{i,t} = \frac{rank(AR_{i,t})}{1 + M_i + L_{2,i}} \qquad (9)$$

The number of non-missing values for the variable $K_{i,t}$ for any t is counted and denoted as N_t. Further we define $\overline{K}_t$ and $S_{\bar{k}}^2$, expressed in equation (10) and (11) respectively.

$$\overline{K}_t = \frac{1}{N_t} \sum_{i=1}^{N} K_{i,t} \qquad (10)$$

$$S_{\bar{k}}^2 = \frac{1}{L_1 + L_2} \sum_{t=T_0}^{T_2} (\bar{K}_t - 0.5)^2$$

(11)

In order to test the null hypothesis E(CAAR)=0, equation (12) and (13) were utilized, where the test statistic is denoted as Z.

$$Z = \sqrt{L_2}\left(\frac{\bar{K}_{T_{1+1,T_2}}\text{-}0.5}{S_{\bar{\mathrm{K}}}}\right)$$

(12)

$$\bar{K}_{T_{1+1,T_2}} = \frac{1}{L_2} \sum_{\mathrm{t}=T_1+1}^{N} \bar{\mathrm{K}}_t$$

(13)

Where:

$\boldsymbol{L_{1,2}}$ Is the number of non-missing $AR_{i,t}$ during the event window.

Z Is the test statistic.

$\boldsymbol{K_{i,t}}$ Is the vector of scaled ranks.

S Is the standard deviation.

$\boldsymbol{N_t}$ Is the number of non-missing K.

In order to test whether there were a significant difference in CAAR between our portfolios of interest during the event windows, we utilized a two sample t-test and Mann-Whitney U-test. The two-sample t-test is a parametric test, while the Mann-Whitney U-test is a nonparametric test. The null hypothesis for the T-test is formulated as μ1 = μ2, where μ1 and μ2 represent the population mean of the CAR values for portfolio 1 and portfolio 2, respectively.

The formula for calculating the test statistic with the two-sample t-test test statistics is given by equation (14):

$$t = \frac{\overline{CAR_1} - \overline{CAR_2}}{\sqrt{\left(\frac{(N_1 - 1)S_1^2 + (N_2 - 1)S_2^2}{N_1 + N_2 - 2}\right)\left(\frac{1}{N_1} + \frac{1}{N_2}\right)}}$$

(14)

The Mann-Whitney U-test is a non-parametric statistical test used to analyze the difference between the medians of different two independent samples, specifically in our study the difference between the medians of CAR-values of two independent portfolios. The Mann-Whitney U-test involves ranking the combined data from both samples, then calculating the sum of the ranks for each sample. The null hypothesis for the test states that there is no significant difference between the median of the two samples, in other word the distribution of both populations are identical (Xia, 2020). The test will provide two values for the test statistic, U_1 and U_2, the lower number is used. With regards to the null hypothesis the test statistics is calculated using equation (15) and (16):

$$U_1 = n_1 n_2 + \frac{n_1(N_1 + 1)}{2} - \mathrm{R}_1$$

(15)

$$U_2 = n_1 n_2 + \frac{n_2(N_2 + 1)}{2} - R_2$$

(16)

Where:

U Is the Mann-Whitney U-test test statistic.

$\boldsymbol{n_1}$ Is the sample size for portfolio 1

$\boldsymbol{n_2}$ Is the sample size for portfolio 2

R_1 Is the sum of the ranks in group 1

R_2 Is the sum of the ranks in group 2

5 DATA

This chapter provides a detailed description of the data used in our study in order to examine the impact of the Russian invasion of Ukraine on European energy sector firms with varying ESG scores and sector characteristics. The study uses daily logarithmic stock returns from September 2, 2021 to March 4, 2022.

5.1 DATA DESCRIPTION

Our study aims at investigating the impact of the Russian invasion of Ukraine on european energy firms during the defined periods (Build-up, Outbreak, and Continuation). The analysis is performed for all the five different sample portfolios, in each of the defined periods to assess whether portfolios with varying firm characteristics reacted differently to the invasion. In essence, we conducted a total of 15 distinct event studies, allowing us to draw comparisons across the resulting data.

Our sample consists of 77 European energy firms, which are sorted into different portfolios based on their ESG score and type of energy. This sorting process results in a total of five portfolios: All_firms, High_ESG, Low_ESG, Renewable, and Non-renewable. As discussed in the literature review, the majority of previous research on the Russia-Ukraine war has been conducted using data for the general European market. Thus, research on the impact on specific industry sectors is limited. Our study aims to fill this gap in the literature by focusing on the European energy sector and examining the effects of the Russian invasion of Ukraine on the performance of firms within this sector.

5.2 DATA SELECTION AND COLLECTION

In this study, we analyzed a sample of 77 European energy firms, by utilizing their daily logarithmic adjusted returns. The stock prices were collected directly into Stata using the fetchyahooquotes command, which imports historical stock prices from Yahoo Finance (Dicle & Levendis, 2011).

According to Fama (1991), daily data is employed to allow for a precise measurement of how quickly stock prices respond to new information. This is in line with the common approach in event studies, as suggested by Kothari and Warner (2006). The analysis excludes days when stock data is unavailable, such as market holidays and weekends. In cases where daily return data for a specific company is missing or incomplete on a certain date, the return for that company on that date is left blank.

The sample firms were randomly selected. However, in order to ensure that the chosen firms align with our research objective, we established a list of selection criteria. The selection criteria and the rationale behind them are presented below.

1) **Geographic location**: The company must be a European company. Companies from Ukraine and Russia are excluded. The rationale behind the exclusion of Russian and Ukrainian companies stems from the assumption that their reactions may diverge significantly from the broader European response due to their direct involvement in the conflict.
2) **Industry sector**: Sample companies must fall within the Energy sector, which includes companies categorized within the fossil fuel or renewable energy sector according to Refinitiv's Business Classification. Additionally, companies from the Utilities sector are included, specifically: Electric utilities from renewable energy sources or multiline utility companies that utilize both renewable and non-renewable energy sources. Utilizing Refinitiv's business classification ensures that the sample consist of firms directly related to energy production or distribution.
3) **Establishment**: The company must be listed on a stock exchange no later than the year 2020. This is to ensure that firms included in the study are well-established and represent stable entities in the market. Newer firms often display more volatility, in addition newer firms could have data missing for the estimation window, which would have led to a less accurate normal performance model.
4) **Data Availability**: The selected company must have sufficient trading data available during the defined Estimation and Event window. This requirement is to ensure that we

had an adequate dataset to conduct our analysis. Without enough trading data, it would be challenging to draw reliable and valid conclusions.

5) **ESG score:** The companies need to have an ESG score for the year 2021. The requirement is included to enable us to answer one of our research questions. Additionally, the ESG scores for 2021, released in 2022, provide the most recent full-year snapshot of a company's ESG performance leading up to the Russian invasion of Ukraine.
6) **Confounding events:** Companies that show significant abnormal returns during the event window due to cofounding factors will be excluded from the analysis. The inclusion of firms with abnormal returns due to cofounding factors might lead to misleading interpretation of the study's results. Thus, it is important to exclude them in order to ensure the validity of the results.

The established data collection procedures and selection criteria resulted in a sample of 77 firms, a complete list of the final sample is presented in the Appendix. These firms categorized using Refinitiv's business classification, span across nine different industry groups. Based on the type of energy source utilized, the firms are further divided into three categories: Renewable, Non-renewable, and Hybrid (utilizing both sources of energy). The industry distribution of the sample firms is detailed in Table (1).

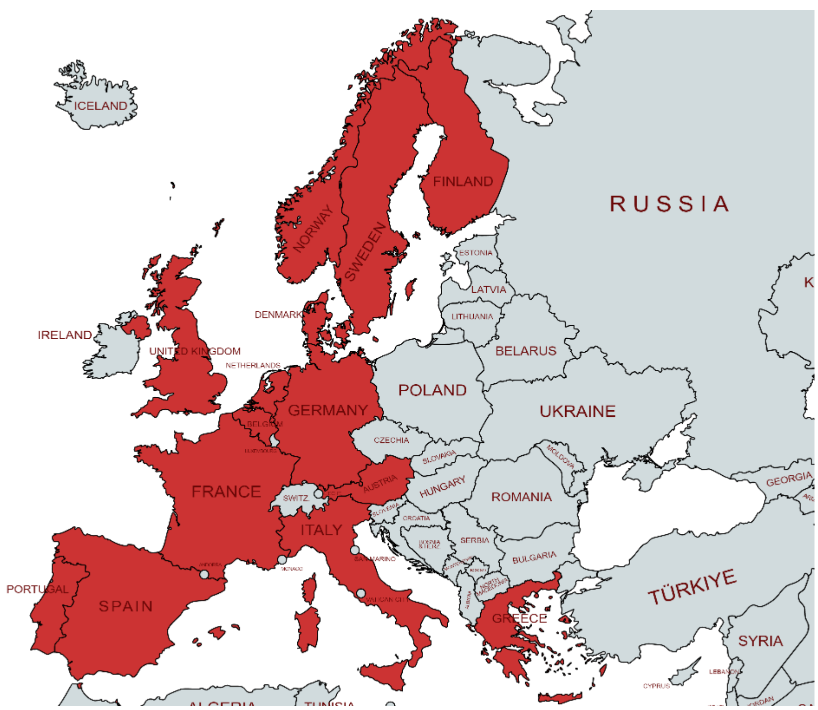
Table (1): Distribution of sample firms by Refinitiv industry category

Non-Renewable	
Oil & Gas company	29
Oil & Gas Related Equipment and Services company	22
Oil & Gas Transportation Services	1
Coal company	1
Renewable	
Renewable Energy company	6
Renewable Energy Equipment & Services	2
Electric Utilities & IPPs company	12
Hybrid	
Electric Utilities & IPPs company	1
Multiline Utilities company	3
Total	77

Table (1) depicts the industry breakdown of the firms within our sample. The majority of the firms, representing 68.8% of the total sample, are classified under non-renewable energy companies. Renewable energy firms constitute 26% of the sample, while 5.3% of the sample is categorized as "hybrid".

Understanding the geographical distribution of the firms within our sample is a significant aspect of this analysis, as it provides a more comprehensive view of the geographic landscape the analysis is based on. Different European countries may possess unique policies, energy frameworks, and environmental regulations that can influence a company's operations and strategic decisions. To offer a clear visual representation of the countries represented in or sample of firms, figure (1) depicts a geographical map of Europe. The map is color-coded, countries with one or more firms in our sample are represented in red, while countries not representing any firms in our sample are shaded gray. The map provides a quick overview of the geographical distribution of our sample across Europe.

Firgure (1): Geographic distribution of sample firms



An interesting pattern that emerges from our sample distribution is the relatively low representation from Eastern Europe. While our study includes companies across diverse economies, Eastern Europe appears to be underrepresented.

Further, table (2) shows the distribution of the number of firms represented from each country represented in the study.

Table (2): Geographic distribution of sample firms

Country	**# Firms**
United Kingdom	19
Norway	14
Germany	10
France	8
Spain	6
Italy	3
Sweden	3
Netherlands	3
Austria	3
Portugal	2
Denmark	2
Greece	2
Finland	1
Belgium	1
Sum	**77**

The tabulated data showcases a prominent clustering of sampled firms originating from the United Kingdom, Norway, Germany, and France. Conversely, there is a lower representation of firms from several other countries. Particularly, the representation of firms from Eastern Europe is noticeably absent within our sample.

5.3 ESG COLLECTION

ESG scores for the sample companies were gathered from Refinitiv's database. This choice stems from Refinitiv's transparent approach to ESG data and their comprehensive coverage of firms. Refinitiv values a high degree of transparency when estimating ESG scores and do not utilize data that isn't disclosed or publicly available (Refinitiv, 2021). However, the utilization of ESG scores from one provider may present a limitation to this study, considering the evidence of variability in ESG scoring across different rating agencies (Berrigan, 2022). The inclusion of ratings from multiple sources could have potentially enhanced the robustness of the study.

It is important to recognize the industry-specific nature of these ESG scores. The evaluation criteria and subsequent scoring are tailored to reflect the unique sustainability challenges and opportunities faced by each industry. Consequently, differing standards and considerations are employed by Refinitiv when evaluating the ESG performance of companies across various energy sub-industries. While our study categorizes the Energy sector into non-renewable and renewable sources, it still involves a comparison of ESG scores across subsectors within these energy sectors. Therefore, it's crucial to acknowledge potential differences in scoring methodology among these sub-industry sectors. The ESG score for each company in our sample is presented in Appendix (A).

5.4 SAMPLE PORTFOLIOS

The total sample of firms is divided into five distinct portfolios, tailored to answer our research questions. Each portfolio represents firms with unique characteristics, allowing to measure whether there are any difference in the impact on stock price between the distinct groups. The five portfolios are as follows:

1. **All_Firms**: This portfolio comprises the entire sample of 77 firms, providing a comprehensive view of the overall market reaction.
2. **High_ESG**: This portfolio comprising the 39 companies with the highest ESG score from the total sample. The High_ESG portfolio's average ESG score stands at 78.4, placing the portfolio in the fourth quartile score range, the fourth quartile is categorized as firms with

excellent relative ESG performance and high degree of transparency in reporting ESG data (Refinitiv, 2022).

3. **Low ESG**: This portfolio includes the 38 companies with the lowest ESG score form the total sample. The Low_ESG portfolio's average ESG score stands at 45.5, placing the portfolio in the second quartile score range, categorized as firms with satisfactory relative ESG performance and moderate degree of transparency in reporting ESG data (Refinitiv, 2022).
4. **Renewable**: This portfolio represents 20 firms classified as renewable energy providers and electric utilities, according to Refinitiv's business classification. This includes firms that supply equipment and services related to renewable energy, those involved in the production of renewable fuels, as well as electric utilities and independent power producers that exclusively utilize renewable energy sources.
5. **Non-Renewable**: This portfolio consists of 53 firms, and encompasses firms classified as Fossil Fuel Energy companies by Refinitiv's business classification. This includes companies involved in the exploration, extraction, refining, along with those providing related equipment or services.

It is worth noting that four firms in the total sample, which use a significant proportion of both renewable and non-renewable energy, have been excluded from the Renewable and Non-Renewable portfolios to maintain the unique focus of each group.

The establishment of the "All Firms" portfolio facilitates the investigation of the first null hypothesis (H0), examining whether the invasion had a significant influence on the stock performance of European energy companies. By including the entire sample of firms in this portfolio, the portfolio offers a holistic view of the overall impact on the stock performance of European energy companies, thereby positioning us effectively to address the first null hypothesis.

The High ESG and Low ESG portfolios are structured to address the second null hypothesis (H01), which investigates whether there exists a significant difference in the cumulative average abnormal returns between firms with High ESG and firms with Low ESG scores. By categorizing firms based on their ESG scores, it allows us to analyze whether there is a connection between a firm's commitment to ESG principles and the stock performance during the event window.

Finally, the Renewable and Non-Renewable portfolios have been constructed to address the third null hypothesis (H02). Examining whether there is a significant difference between the cumulative average abnormal returns between renewable and non-renewable energy firms during the event window. These portfolios allow us to compare, and determine if there is any difference of the impact on European energy companies based on the type of energy type they utilize.

5.5 EVENT STUDY SPECIFIC DATA

This section aims to provide a brief overview of decisions made in relation to the event study methodology. We will delve into the selection process for estimation and event windows, the choice of the market index, and the selection of the model for estimating normal performance. Each of these components plays a crucial role in structuring our event study and ensuring the accuracy and validity of our results.

5.5.1 Eventstudy2

The Event study is conducted in Stata utilizing the Eventstudy2 Stata module. This tool is highly suitable for our analysis as it offers multiple model specifications that have been well-established in finance and related literature (Kaspereit, 2022). The Stata code, along with the dataset used, is attached as an external file to this thesis.

5.5.2 The Event Date and Event Window

In this subchapter, we describe our choice and rationale behind the chosen event date and event window in our event study. Our event study consists of three event windows: build-up, outbreak, and continuation. The primary event of interest is the Russian invasion of Ukraine, which occurred on February 24, 2022. This date marks the event date within the outbreak event window. To capture the full market reaction, the outbreak event window spans from two trading days before the invasion (t_{-2}) to eight trading days after t_8, which corresponds to real dates between February 22 and March 8.

The build-up period starts January 24 (t_0) and ends February 21 (t_{20}), the build-up period is included in an effort to assesses the presence of abnormal returns before the invasion. Although the invasion surprised many, there was a significant build-up period prior to the war, we chose to sett the lower bound of the build-up period to January 24, as this is the day NATO deployed of troops in Eastern Europe to support Ukraine. As such, the invasion was not entirely unexpected, and information regarding the increasing tension could lead to abnormal returns during this period.

Lastly, the continuation period, ranging from March 9 (t_0) to April 6 (t_{20}), examines whether abnormal returns persisted while the war was ongoing and additional sanctions were imposed. The cut-off date on April 6 is admittedly somewhat arbitrary. However, our aim is to assess the presence of abnormal returns during this period of continued conflict and further imposed sanctions.

5.5.3 The Estimation window

In this study, the estimation window spans from March 10, 2021, to December 27, 2021, encompassing a total of 207 trading days. The estimation window ends 20 trading days prior to the lower bound of the Build-up period on January 24, ensuring that there is no spillover effect from the event windows on the normal performance model. The same estimation period is used for all event windows to maintain a consistent normal performance model when calculating abnormal returns across all event windows. This duration is in line with the recommendations of Krivin et al. (2003), who propose that an estimation window ranging from 60 days to one year is an appropriate length for the estimation window.

5.5.4 The Market Index

To estimate our normal performance model, it is essential to select data that accurately represents the overall market return. In our study, which focuses on European stocks, we chose to use MSCI Europe Index. MSCI Europe index is a general European market index. The index is based on large and mid-cap firms across 15 Developed Markets in Europe. With 423 constituents, the index covers approximately 85% of the free float-adjusted market capitalization across the European Developed Markets equity universe (MSCI, 2023). Daily market returns for the period from March 10, 2021, to December 27, 2021, are utilized. The period spans the entire duration of our estimation window.

5.5.5 Estimating Normal performance

MacKinlay, (1997) suggests that the benefits of employing multi-factor models for event studies are generally limited. However, in cases where the sample firms share common characteristics, such as being part of the same industry or having similar market capitalization, the use of a multi-factor model can be more advantageous. For that reason, a multifactor model suits our study as it accounts for the unique characteristics of the sample firms, which all belong to the energy sector and share similar features as European companies. For this purpose, we have chosen to use the Fama-French 3-factor model, which is a widely recognized and well-established model in the field of finance.

6 EMPIRICAL FINDINGS & RESULTS

6.1 INTRODUCTION

The Purpose of this study was to examine the stock price reaction of European energy firms to the Russian invasion of Ukraine. As well as determining whether the impact of the event on the stock prices differs between firms with different ESG characteristics, or if there was a differential impact between firms in the renewable and non-renewable sector. The event study methodology was employed to test our hypotheses. The first null hypothesis proposes that the cumulative average abnormal return (CAAR) during the outbreak period is zero. Two-sample t-test and the Mann Whitney U-test was utilized in order to test our second and third null hypotheses, which suggests that there is no difference in CAAR between the High_ESG and Low ESG_portfolios, as well as between the Renewable and Non-Renewable portfolios.

In This section of the thesis the empirical findings from our event study is presented. Results from each portfolio: All_firms, High_ESG, Low_ESG, Renewable, and Non_renewable will be presented across three event windows: the build-up, outbreak, and continuation periods.

We placed particular emphasis on the outbreak period due to the significant CAAR values it portrayed across every portfolio in this period. It's worth noting that the build-up and continuation periods did not exhibit significant CAAR values. To maintain clarity and avoid a huge body of data in this chapter, a summarization table that encapsulates the findings across all periods, including both the Outbreak and Continuation stages is provided. More in-depth statistical details for the build-up and continuation periods were relegated to appendix (B). This ensured that the focus remained on the most relevant findings in the body of the chapter, while still providing detailed data for those who wish to delve deeper.

6.2 Outbreak Period

Table (3) displays the daily Average Abnormal Returns (AAR) for the All_firms portfolio throughout the outbreak period's event window. The table also displays the Cumulative Average Abnormal Returns (CAAR) for the entire event window, highlighted in blue. The day Russia invaded Ukraine is denoted as t_0. The test statistics for both daily AAR and CAAR, derived from the two-sided crude adjusted t-test, are shown in the T-test column, while the Corrado test statistics are displayed in the Corrado column. The respective significance levels for both tests are also provided next to their corresponding test statistics. The "NoFirms" column portrays the number of firms in the portfolio of interest.

Table 3: AAR, CAAR and test statistics for all firms during the outbreak period

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
all firms	-2	77	0,00001	0,00143		-0,02132	
all firms	-1	77	0,00119	0,28663		0,08674	
all firms	0	77	0,04121	8,83232	***	2,45342	**
all firms	1	77	-0,01395	-3,05855	***	-1,53642	
all firms	2	77	0,03341	7,93221	***	2,71976	***
all firms	3	77	0,01750	4,00919	***	1,26132	
all firms	4	77	0,02032	4,89285	***	1,53000	
all firms	5	77	0,00117	0,25298		-0,58437	
all firms	6	77	0,02239	4,86345	***	1,86993	*
all firms	7	77	0,04651	11,03522	***	2,63507	***
all firms	8	77	0,04685	11,25244	***	3,09416	***
all firms	[-2;8]	77	0,21660	14,00408	***	4,07290	***

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

The data outlined in Table (3) suggests there was no significant AAR in the two days preceding the invasion. However, on the event day, denoted as t_0, a significant positive AAR of 0.04121 is observed. This AAR is significant based on both the t-test and the Corrado test, signifying a significant positive reaction in energy firms' stock prices on the day of the invasion. However, the day after the invasion on day t_1, the data reveals a significant negative AAR.

For the remainder of the event window, the AARs are primarily positive and statistically significant according to the t-test, except for t_5 , which shows a small positive AAR that is not statistically significant in either the t-test or the Corrado test.

Moreover, the results show a substantial positive CAAR value of 0.2166, significantly different from zero at a 99% confidence level on both the t-test and the Corrado test. This suggests that the All_firms portfolio performed 21.66% better during the outbreak period than it would have in the theoretical absence of the invasion. This result provides sufficient evidence to reject the first null hypothesis and thus support the alternative hypothesis.

Table (4) shows the daily AAR and CAAR for the High_ESG portfolio during the outbreak period, following the same format as the previous table.

Table 4: AAR, CAAR and test statistics for the High-ESG portfolio during the outbreak period.

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
High ESG	-2	39	-0,00342	-0,70402		-0,24004	
High ESG	-1	39	-0,00045	-0,09216		-0,11819	
High ESG	0	39	0,04393	7,64962	***	1,92949	*
High ESG	1	39	-0,01214	-2,18012	**	-1,23869	
High ESG	2	39	0,02330	4,68148	***	1,72335	*
High ESG	3	39	0,00146	0,27866		0,17774	
High ESG	4	39	0,01955	4,02996	***	1,24968	
High ESG	5	39	-0,00311	-0,54442		-0,83556	
High ESG	6	39	0,01963	3,48743	***	1,54836	
High ESG	7	39	0,04030	8,10943	***	2,16312	**
High ESG	8	39	0,04400	9,02989	***	2,51036	**
High ESG	[-2;8]	39	0,17306	8,93848	***	2,67429	***

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

Data for the High_ESG portfolio outlined in table (4) suggest there was no significant AAR in the two days prior to the invasion. The event day (t_0) a show a significant positive AAR of 0.04121, followed by a negative AAR on the day after the event day (t_1). For the remaining days of the event window, the AAR is mainly positive and significant with regard to the t-test, with the exception of t_3 and t_5. The results display a positive CAAR value of 0.17306, significantly different from zero at a 99% confidence level on both the t-test and the Corrado test.

Table (5) displays the daily AAR and CAAR for the Low_ESG portfolio during the outbreak period, following the same format as the previous table.

Table 5: AAR, CAAR and test statistics for the Low-ESG portfolio during the outbreak period.

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
Low ESG	-2	38	0,00353	0,51954		0,76526	
Low ESG	-1	38	0,00287	0,42295		0,71329	
Low ESG	0	38	0,03842	5,19712	***	0,00555	***
Low ESG	1	38	-0,01582	-2,17665	**	0,09048	*
Low ESG	2	38	0,04378	6,40394	***	0,00024	***
Low ESG	3	38	0,03397	4,83319	***	0,00925	***
Low ESG	4	38	0,02111	3,11152	***	0,09643	*
Low ESG	5	38	0,00555	0,76252		0,90672	
Low ESG	6	38	0,02523	3,44352	***	0,04535	**
Low ESG	7	38	0,05289	7,72039	***	0,00441	***
Low ESG	8	38	0,04977	7,32526	***	0,00071	***
Low ESG	[-2;8]	38	0,26129	10,68932	***	5,36826	***

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 1%, ** for 5%, and * for 10% confidence levels.*

Data for the Low_ESG portfolio outlined in table (5) suggest there was no significant AAR in the two days prior to the invasion. On the event day (t_0) the Low_ESG portfolio show a significant positive AAR of 0.03842, followed by a negative AAR on the day after the event day (t_1). For the remaining days of the event window, the AAR is mainly positive and significant with regard to the t-test, with the exception of t_5. The results display a positive CAAR value of 0.26129, significantly different from zero at a 99% confidence level on both the t-test and the Corrado test. The Low_ESG portfolio portray a higher CAAR value than the High_ESG portfolio.

Figure (2) visually displays the daily AAR during the outbreak event window for the High_ESG, Low_ESG and All_firms portfolios.

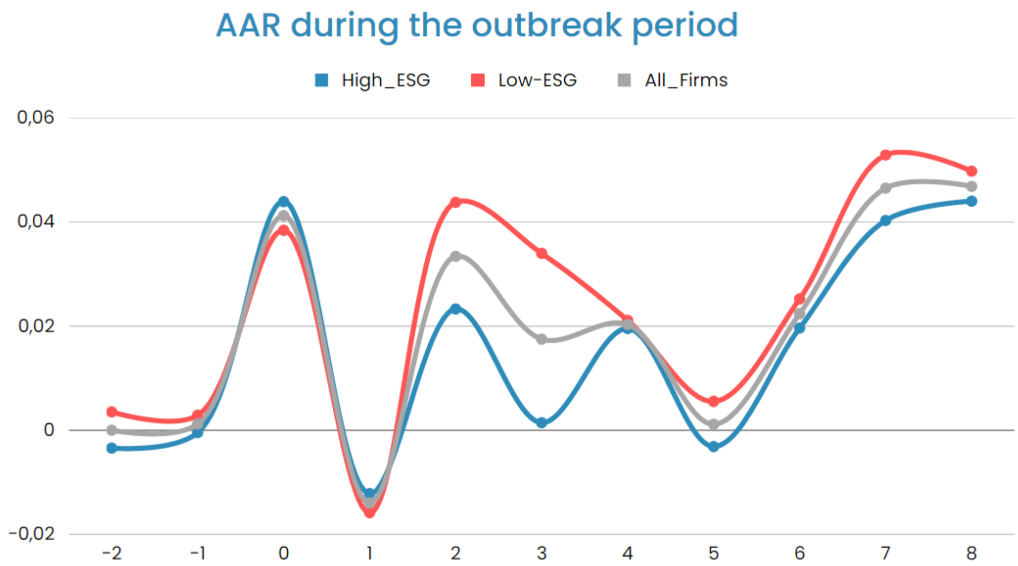


Figure 1: Average Abnormal Returns for portfolios High_ESG, Low_ESG and All_firms during the outbreak period

Figure (2) allows for a graphical comparison of the AARs between the High and Low_ESG portfolios during the outbreak event window. As illustrated in the figure, from t2 to t8, the AAR of the Low_ESG portfolio exceeds that of the High_ESG portfolio. This aligns with the expectations given that the Low_ESG portfolio demonstrated a higher CAAR value than the High_ESG portfolio.

Table (6) displays the daily AAR and CAAR for the Renewable portfolio during the outbreak period, following the same format as the previous table.

Table 6: AAR, CAAR and test statistics for the Renewable portfolio during the outbreak period

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
Renewable	-2	20	-0,00345	-0,66822		-0,42065	
Renewable	-1	20	0,00553	1,07182		0,43530	
Renewable	0	20	0,08387	14,90424	***	2,61915	***
Renewable	1	20	-0,00176	-0,31867		-0,36788	
Renewable	2	20	0,07743	14,88089	***	3,05299	***
Renewable	3	20	0,00300	0,56132		0,27994	
Renewable	4	20	-0,01026	-1,98677	**	-0,47634	
Renewable	5	20	-0,00816	-1,47267		-0,87794	
Renewable	6	20	0,03760	6,74339	***	2,18092	
Renewable	7	20	0,05927	11,36525	***	2,15747	**
Renewable	8	20	0,06763	13,07873	***	2,70856	**
Renewable	[-2;8]	20	0,31069	16,53365	***	3,40450	***

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

Results for the renewable portfolio outlined in table (6) suggest there was no significant AAR in the two days prior to the invasion. On the event day (t_0) the renewable portfolio shows a significant positive AAR of 0.08387, followed by a non significant negative AAR on the day after the event day (t_1). For the remaining days of the event window, the AAR is mainly positive and significant with regard to the t-test, with the exception of day t_5 and t_3 . Day t_4 displays a significant negative AAR with regard to the t-test. The results display a positive CAAR value of 0.31069, significantly different from zero at a 99% confidence level on both the t-test and the Corrado test. The Renewable portfolio portrays the highest CAAR value of our 5 sample portfolios during the outbreak period.

Table (7) displays the daily AAR and CAAR for the Non-Renewable portfolio during the outbreak period, following the same format as the previous table.

Table 7: AAR, CAAR and test statistics for Non-renewable portfolio during the outbreak period.

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
Non-Renewable	-2	53	0,00158	0,27817		0,19957	
Non-Renewable	-1	53	-0,00035	-0,06144		-0,08880	
Non-Renewable	0	53	0,02909	4,53763	***	1,62842	
Non-Renewable	1	53	-0,02108	-3,36575	***	-1,69463	*
Non-Renewable	2	53	0,01836	3,18225	***	1,46320	
Non-Renewable	3	53	0,02723	4,54918	***	1,33015	
Non-Renewable	4	53	0,03602	6,33553	***	2,03313	**
Non-Renewable	5	53	0,00642	1,01280		-0,10798	
Non-Renewable	6	53	0,01844	2,91605	***	1,11171	
Non-Renewable	7	53	0,04711	8,16056	***	2,04860	**
Non-Renewable	8	53	0,04113	7,21635	***	2,02013	**
Non-Renewable	[-2;8]	53	0,20394	9,56637	***	2,99807	***

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

Similar to the rest of the sample portfolios, as displayed in table (7) the Non-renewable portfolio does not display significant AAR in the two days prior to the invasion. On the event day (t_0) the Non-Renewable portfolio show a significant positive AAR of 0.02909, followed by a significant negative AAR on the day after the event day (t_1). For the remaining days of the event window, the AAR is mainly positive and significant with regard to the t-test, with the exception of day t_5. The results display a positive CAAR value of 0.20394, significantly different from zero at a 99% confidence level on both the t-test and the Corrado test.

Figure (3) visually displays the daily AARs during the outbreak event window for the Renewable, Non_Renewable and All_firms portfolios.

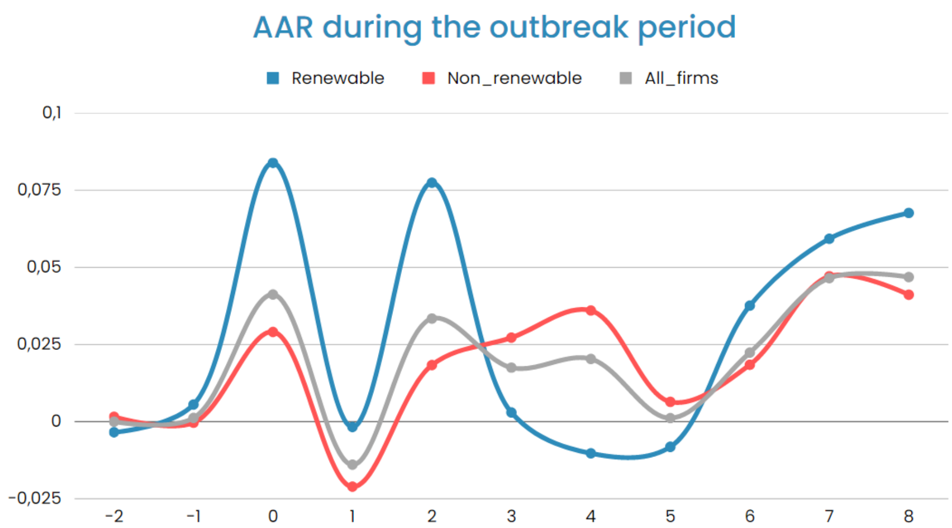


Figure 3: Average Abnormal Returns for portfolios Renewable, Non_renewable and All_firms during the outbreak period.

Figure (3) allows for a graphical comparison of the AARs between the Renewable, Non-Renewable and All_firms portfolio during the outbreak event window. The figure reveals that on days t_0 and t_2, the Renewable portfolio exhibits a considerably higher AAR value compared to both the Non-renewable and All_firms portfolios. It should be noted that the larger variability in the AAR of the Renewable portfolio could potentially be attributed to the smaller sample size.

6.3 CAAR SUMMARY

In an effort to summarize the key findings from our study, table (8), (9) and (10) presents the CAAR value for each portfolio during the build-up (jan.24 – feb.21), outbreak (Feb.22 – Mar.8), and continuation period (Mar.9 – Apr.6). To evaluate whether the CAAR is statistically different from zero, the respective t-test and Corrado test statistics are also included.

Table 8: CAAR and test statistics for all portfolios during the build-up period.

Build-up	*Event window*	*NoFirms*	*CAAR*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
all firms	[0;20]	77	-0,01967	-0,95332		-0,07869	
High ESG	[0;20]	39	-0,02548	-0,97742		0,77288	
Low ESG	[0;20]	38	-0,01370	-0,42264		-0,63636	
Renewable	[0;20]	20	-0,05204	-2,08625	**	-1,09710	
Non-renewable	[0;20]	53	-0,00953	-0,33494		0,37369	

*CAAR denotes the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

As shown in Table (8), the Renewable portfolio is the only portfolio displaying a significant CAAR value during the Build-up period. With a t-value of (-2,08625), the data indicates a significant negative CAAR value at a 95% confidence level. However, the Corrado test does not signify a significant CAAR value for the Renewable portfolio. Additional none of the other groups appear to have experienced significant CAAR during the build-up period of our event study.

Table 9: CAAR and test statistics for all portfolios during the outbreak period.

Outbreak	Event window	NoFirms	CAAR	T-test	T-test significance	Corrado	Corrado significance
all firms	[-2;8]	77	0,21660	14,00408	***	4,07290	***
High ESG	[-2;8]	39	0,17306	8,93848	***	2,67429	***
Low ESG	[-2;8]	38	0,26129	10,68932	***	5,36826	***
Renewable	[-2;8]	20	0,31069	16,53365	***	3,40450	***
Non-Renewable	[-2;8]	53	0,20394	9,56637	***	2,99807	***

*CAAR denotes the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

Table (9) displays the CAAR values for the Outbreak period. As shown in the table all of the sample portfolios experienced positive CAAR values. Both the T-test and the Corrado test statistics are significant at 99% confidence level. This implies that the Russian-Ukraine war had a significant positive impact on the stock performance of our sample portfolios during the outbreak period.

Table 10: CAAR and test statistics for all portfolios during the continuation period.

Continuation	Event window	NoFirms	CAAR	T-test	T-test significance	Corrado	Corrado significance
all firms	[0;20]	77	0,00483	0,25052		0,79882	
High ESG	[0;20]	39	-0,02581	-1,116191		0,27025	
Low ESG	[0;20]	38	0,03628	1,15586		1,42435	
Renewable	[0;20]	20	-0,03057	-1,26505		-0,02962	
Non-renewable	[0;20]	53	0,01850	0,69747		0,85993	

*CAAR denotes the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

As shown in Table (10), The CAAR values are relatively close to zero for every portfolio. The T-test and Corrado test statistics do not indicate any significant CAAR values for any of the portfolios during the continuation period.

6.4 Difference in CAAR between sample portfolios

The table (11) presents the P-values of the two-sample two-tailed t-test and the Mann-Whitney U test. The test is performed in order to check if there is a significant difference in the CAAR values between the High_ESG and the Low_ESG portfolio and renewable and the non_Renewable portfolio during the buildup, outbreak, and continuation periods. The test statistics are computed based on the firm specific cumulative abnormal return value for every firms within each respective portfolio during the different time periods.

Table 11: P-values for T-test and Mann-Whitney U-test, testing for significant difference between portfolios during build-up, outbreak and continuation period.

Comparison	Build-up period	Outbreak period	Continuation period
High ESG vs Low ESG			
Two-sample T-test	(0,82051)	(0,10848)	(0,16685)
Mann-Whitney U-test	(0,06432) *	(0,02926) **	(0,42372)
Renewable vs Non-renewable			
Two-sample T-test	(0,24392)	(0.08271) *	(0,3567)
Mann-Whitney U-test	(0,0278) **	(0,08914) *	(0,7414)

*Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels*

As displayed in table (11) during the outbreak period, the Mann-Whitney U-test signifies a significant difference in CAAR between the high and low-ESG portfolios. However only at a 90% confidence level, in addition the P-value of the T-test is high (0.82051) and does not indicate any significant difference between the two portfolios in the build-up period. Further, the Mann-Whitney test also indicates a significant difference between the Renewable and non-renewable portfolio, with a p value of (0,0278) thus significant at a 95% level. However the T-test does not signal any significant difference between the two portfolios during the build-up period.

During the outbreak period, the Mann-Whitney U-test signifies a significant difference between the High and Low-ESG portfolio at a 95% confidence level. However the T-test does not indicate any significant difference between the two groups. Regarding the renewable and non-renewable portfolios, both the T-test and the Mann-Whitney U-test demonstrate a significant difference in CAR at the 10% confidence level.

In the Continuation period, neither the T-test nor the Mann-Whitney U-test indicates any significant difference in CAR between high and low-ESG portfolios, or between the renewable and non-renewable portfolios.

7 Discussion

The research conducted in this thesis demonstrated that our sample portfolios with European energy firms experienced significant positive cumulative average abnormal returns (CAAR) during the outbreak phase of Russia's invasion of Ukraine. This significant effect was consistently reflected across all five sample portfolios. However, this trend didn't extend to the Build-up and Continuation phases, which failed to present significant CAAR values. This suggests that the immediate stock reaction during the Outbreak period was the most consequential for the sample firms. In addition to these findings, the study delved deeper to discern any substantial variations in the CAAR values between portfolios of High ESG and Low ESG firms, as well as between renewable and non-renewable energy corporations throughout the build-up, outbreak, and continuation phases of the event.

Notably, the Low_ESG portfolio outperformed its High_ESG counterpart, demonstrating superior CAAR values across all three event periods. This disparity is reinforced by the outcomes of both the Mann-Whitney U-test and the Two-sample T-test, which identify a significant difference between the High_ESG and Low_ESG portfolios during the outbreak period. This implies that firms with lower ESG ratings experienced superior stock performance during the outbreak phase spanning from February 22nd to March 8th. These observations resonate with the findings from research conducted by of Lööf et al. (2021), which posits that superior ESG ratings correlate with lower downside risk and lower upside return potential. This seems to fit the results observed in our study. Additionally, this pattern also aligns with research conducted by De & Clayman's (2015), which identified a negative correlation between ESG rating and stock volatility, a correlation which intensifies under conditions of high market volatility.

When evaluating the differences in CAAR between renewable and non-renewable energy firms across the build-up, outbreak, and continuation periods, the findings present a inconsistent picture. The renewable portfolio exceeded the non-renewable one in terms of CAAR during the outbreak, but the latter demonstrated superior performance during the build-up and continuation periods. Testing for significant difference between the two portfolios revealed varied results, the non-renewable portfolio outperformed during the build-up, while the renewable portfolio performed better during the outbreak period. Therefore, the evidence suggesting one portfolio significantly outperformed the other is rather weak.

Originally, it was hypothesized that the non-renewable portfolio would perform significantly better than the renewable portfolio due to the sharp increase in oil prices during the outbreak period. However, the actual results challenge this initial assumption. On the other hand, these observations align with the findings from a paper by Deng et al. (2022), which explored the impact of the Russian invasion of Ukraine on US and European markets. Their results suggested that in Europe, stocks less exposed to the regulatory risks related to low-carbon transition demonstrated superior performance during the event. This may be an indication that the market anticipated a strong policy response in Europe favoring energy from renewable sources. Nonetheless, these conclusions should be approached with caution. One limitation of this study is the relatively small number of sample firms within the renewable portfolio, which could potentially account for the greater variability in AAR observed within this group.

A noteworthy observation from the analysis is the significant positive AARs recorded for all five portfolios on the day of the invasion (t_0), during the outbreak period (24th February 2022).

However, the subsequent day (t_1), saw significant negative AARs in four out of the five portfolios. This fluctuation could suggest a market overreaction to the initial event, followed by a correction the next day. This pattern raises interesting questions regarding the efficient market hypothesis, which postulates that markets will adjust instantly to new information. Yet, this doesn't always seem to align with real-world behavior. Research proposed by Bondt and Thaler (1990), suggests that markets often overreact to new information, leading to extreme price swings that surpass their intrinsic value before eventually settling back to an equilibrium price. Fama (1991) suggested that event studies provide the most compelling evidence supporting market efficiency, thus our analysis can be viewed as an empirical test of market efficiency. Nevertheless, one should consider the possibility that the emergence of new information to the market on day t_1 also could have influenced those results.

Previous studies, as reviewed in our literature review, predominantly analyzed the impact of the Russian invasion of Ukraine on the global and European markets. These studies primarily showcased a significant negative market reaction to the invasion. However, a gap in the literature persists regarding the specific effects on the stock price impact on energy firms, and more specified, the return discrepancies based on ESG factors or energy firm type. Thus, the present study aims to contribute to the existing literature by addressing this area.

This research carries significant relevance, shedding light on how geopolitical events, such as the Russian invasion of Ukraine, influence the stock prices of European energy firms. These findings hold substantial value for investors and financial analysts who are tasked with making informed resource allocation decisions amidst similar geopolitical incidents. Furthermore, the study enriches the existing body of ESG research. It underscores the critical role of ESG ratings in risk management during periods of crisis and instability. The outcomes reaffirm existing evidence asserting that superior ESG ratings are associated with lower downside risk and a reduced potential for upside returns. In effect, it solidifies the role of ESG considerations in crafting effective investment strategies, particularly during volatile times.

However, while this study offers valuable insights, there are certain limitations that might influence the precision and applicability of the results. The total sample size of 77 firms utilized in this study, divided into distinctive portfolios, may be considered somewhat small to accurately represent the European energy market. This limitation is particularly pronounced in the Renewable portfolio, which comprises only 20 firms. In addition, as depicted in table (2) there is a notable concentration of firms from the United Kingdom, Norway, and Germany in our sample may lead to these countries having a greater influence on the overall findings of the study. This heavy skew towards certain countries could impact the generalizability of the results across the entire European context. On the other hand, the minimal representation from other countries could limit the insights drawn about these regions. Similarly, the lack of representation from Eastern European countries suggests that the results of the study may not fully capture the impact of the event on the energy sector across all regions of Europe. This lack of representation may potentially introduce some bias in the findings, limiting the scope of inference for these underrepresented regions.

Furthermore, the reliance on ESG scores from a single provider could also impose a limitation on this study. Existing literature suggests significant discrepancies in ratings awarded to European companies by different ESG providers (Zumente & Lāce 2021). Incorporating ratings from multiple sources might have amplified the robustness of the study.

Another potential limitation is the presence of confounding events that may influence a firm's abnormal return during the event window. We made an effort to mitigate this by examining firms with high abnormal returns for any other firm specific events, apart from the invasion, that could have influenced the stock price. While some firms were removed from the sample due to these confounding events, we cannot guarantee that other unknown events did not impact the remaining sample firms during the event windows. Therefore, results should be interpreted with these potential confounding influences in mind.

Despite the limitations, this study offers valid results for the purpose of answering our research questions. Our aim was to enhance the existing literature by examining the impact of the Russian invasion of Ukraine on the European market, and in doing so, broaden the understanding of ESG investing. The thesis was aimed at providing a meaningful contribution to the ongoing discourse on ESG factors, industry specificity, and stock performance during geopolitical turmoil.

8 Conclusion

This study aimed to investigate the impact of the Russian invasion of Ukraine on the stock performance of European energy companies, along with exploring the potential disparity in cumulative average abnormal returns between firms with High and Low ESG scores and renewable and non-renewable energy firms during the invasion period.

Our results convincingly showed that the Russian invasion had a significant positive impact on the stock performance of European energy companies during the outbreak period. Consequently, we reject the first null hypothesis and accept the alternative hypothesis that states that the Russian invasion of Ukraine had a significant impact on stock performance of European energy companies.

Further, we found substantial evidence to reject the second null hypothesis, indicating that there is a significant difference in CAAR between firms with High and Low ESG scores during the period surrounding the invasion. Interestingly, companies with Low ESG ratings exhibited significantly better stock performance, a result that aligns with earlier research suggesting that superior ESG ratings often correlate with lower downside risk and lower upside return potential.

As for the third research question, the study found mixed results for renewable and non-renewable energy firms. Results indicated a significant difference in CAAR during the build-up and outbreak periods, but the direction of these results was inconsistent. The evidence does not indicate that one of the portfolios performed better than the other, thus we do not reject the third null hypothesis.

Our study contributes new insights into how geopolitical events affect different segments of the energy industry, particularly highlighting the role of ESG scores and the type of energy firm. The findings offer practical guidance for investors and financial analysts, allowing them to make more informed decisions during similar geopolitical events.

Furthermore, this study adds to the body of ESG research, emphasizing the importance of ESG ratings in risk management during periods of crisis and instability. For future research, it would be beneficial to investigate this topic with a larger sample size and improved geographical distribution. In addition, it would be intriguing to investigate how a firm's geographical proximity to the conflict influences the events' impact on the firms stock price. Further, as markets continue to evolve, research into the relationship between ESG ratings and stock performance could provide valuable insights into how sustainability factors influence investor behavior and market dynamics. Lastly a thrilling prospect for future exploration would be to unravel how Europe's quest for energy independence from Russia in the aftermath of the invasion may have unexpectedly turbocharged the shift towards a greener energy industry.

References

Ahmed, S., Hasan, M. M., & Kamal, M. R. (2022). Russia–Ukraine crisis: The effects on the European stock market. *European Financial Management*. https://doi.org/10.1111/eufm.12386

Baldwin, S. (2022, April 8). *The role of natural gas in the Russia-Ukraine conflict*. CNBC. https://www.cnbc.com/2022/04/08/the-role-of-natural-gas-in-the-russia-ukraine-conflict.html

Bao, R., Chen, M., & Zhang, S. (2022). The impact of the Russia-Ukraine war on European energy stock prices. *BCP Business & Management, 32*, 418–424. https://doi.org/10.54691/bcpbm.v32i.2961

bashir, N., mackintosh, E., Hodge, N., & Pavolva, U. (2022, February 7). *Macron meets with Putin, leading Europe's diplomatic efforts to defuse Ukraine crisis*. CNN. https://www.cnn.com/2022/02/07/europe/ukraine-russia-news-monday-intl/index.html

BBC. (2022, February 21). Putin announces Donetsk and Luhansk recognition. *BBC News*. https://www.bbc.com/news/av/world-europe-60470900

BBC. (2022, March 9). Ukraine war: Oil price rises again due to fears over Russian shortfall. *BBC News*. https://www.bbc.com/news/business-60680787

Berrigan, M. J. (2022). *Ref: Outcome of ESMA Call for Evidence on Market Characteristics of ESG Rating and Data Providers in the EU*.

Bertrand, N., Starr, B., & Herb, J. (2022, February 2). *US troops to deploy to Eastern Europe amid Ukraine crisis | CNN Politics*. CNN. https://www.cnn.com/2022/02/02/politics/us-troops-europe-russia/index.html

Borger, J., & Roth, A. (2021, December 7). Biden and Putin make little apparent headway on Ukraine in virtual summit. *The Guardian*. https://www.theguardian.com/world/2021/dec/07/joe-biden-vladimir-putin-virtual-summit-ukraine-russia

Boungou, W., Osei-Tutu, F., Yatie, A., & Zongo, A. M. I. (2022). *The Ukraine-Russia War and Systemic Financial Stress* (SSRN Scholarly Paper No. 4301394). https://papers.ssrn.com/abstract=4301394

Breedt, A., Ciliberti, S., Gualdi, S., & Seager, P. (2018). *Is ESG an Equity Factor or Just an Investment Guide?* (SSRN Scholarly Paper No. 3207372). https://doi.org/10.2139/ssrn.3207372

Brown, S. J., & Warner, J. B. (1980). Measuring security price performance. *Journal of Financial Economics*, *8*(3), 205–258. https://doi.org/10.1016/0304-405X(80)90002-1

Corrado, C. J. (1989). A nonparametric test for abnormal security-price performance in event studies. *Journal of Financial Economics*, *23*(2), 385–395. https://doi.org/10.1016/0304-405X(89)90064-0

De, I., & Clayman, M. (2014). *The Benefits of Socially Responsible Investing: An Active Manager's Perspective* (SSRN Scholarly Paper No. 2464204). https://doi.org/10.2139/ssrn.2464204

Deng, M., Leippold, M., Wagner, A. F., & Wang, Q. (2022). *The Net-Zero Transition and Firm Value: Insights from the Russia-Ukraine War, REPowerEU, and the US Inflation Reduction Act* (SSRN Scholarly Paper No. 4080181). https://doi.org/10.2139/ssrn.4080181

Dicle, M. F., & Levendis, J. (2011). Importing Financial Data. *The Stata Journal*, *11*(4), 620–626. https://doi.org/10.1177/1536867X1201100408

European Commission. (2022, April 20). *In focus: Reducing the EU's dependence on imported fossil fuels*. https://commission.europa.eu/news/focus-reducing-eus-dependence-imported-fossil-fuels-2022-04-20_en

European Council. (2022, February 27). *Statement by President von der Leyen on further measures to respond to the Russian invasion of Ukraine*. https://neighbourhood-enlargement.ec.europa.eu/news/statement-president-von-der-leyen-further-measures-respond-russian-invasion-ukraine-2022-02-27_en

European Council. (2023a, April 13). *Timeline—EU restrictive measures against Russia over Ukraine*. European Council. https://www.consilium.europa.eu/en/policies/sanctions/restrictive-measures-against-russia-over-ukraine/history-restrictive-measures-against-russia-over-ukraine/

European Council. (2023b, April 14). *EU sanctions against Russia explained*. https://www.consilium.europa.eu/en/policies/sanctions/restrictive-measures-against-russia-over-ukraine/sanctions-against-russia-explained/

eventstudytools. (2023). Significance Tests for Event Studies. *Journal of Financial Economics*, *30*(2), 253–272. https://doi.org/10.1016/0304-405X(91)90032-F

Fama, E. F., & French, K. R. (1992). The Cross-Section of Expected Stock Returns. *The Journal of Finance*, *47*(2), 427–465. https://doi.org/10.1111/j.1540-6261.1992.tb04398.x

Freeman, R. E. (2015). *Strategic Management: A Stakeholder Approach*. Cambridge University Press. https://doi.org/10.1017/CBO9781139192675

Friede, G., Busch, T., & Bassen, A. (2015). *ESG and Financial Performance: Aggregated Evidence from More than 2000 Empirical Studies* (SSRN Scholarly Paper No. 2699610). https://papers.ssrn.com/abstract=2699610

FTSE Russell. (2018). *Smart beta: 2018 global survey findings from asset owners*. FTSE Russell. https://hub.ipe.com/asset-manager/ftse-russell/smart-beta-2018-global-survey-findings-from-asset-owners/10024853.supplierarticle

Godfrey, P. C. (2005). The Relationship Between Corporate Philanthropy And Shareholder Wealth: A Risk Management Perspective. *Academy of Management Review*, *30*(4), 777–798. https://doi.org/10.5465/amr.2005.18378878

Hodge, N., John, T., & Chernova, A. (2022, February 10). *Russia and Belarus hold joint military exercises as diplomatic talks ramp back up*. CNN. https://www.cnn.com/2022/02/10/europe/ukraine-russia-news-thursday-military-exercises-intl/index.html

Interfax. (2022, May 21). *Ukraine applied to join NATO in 2008, application not withdrawn, final decision on country's entry should now be made by NATO members – Stefanishyna*. Interfax-Ukraine. https://en.interfax.com.ua/news/general/833852.html

Kaspereit, T. (2022). EVENTSTUDY2: Stata module to perform event studies with complex test statistics. *Statistical Software Components*. https://ideas.repec.org//c/boc/bocode/s458086.html

Kothari, S. P., & Warner, J. B. (2004, October 20). *The Econometrics of Event Studies*. https://papers.ssrn.com/sol3/papers.cfm?abstract_id=608601

Krivin, D., Patton, R., Rose, E., & Tabak, D. (2003). Determination of the Appropriate Event Window Length in Individual Stock Event Studies. *SSRN Electronic Journal*. https://doi.org/10.2139/ssrn.466161

Lööf, H., Sahamkhadam, M., & Stephan, A. (2021). Is Corporate Social Responsibility investing a free lunch? The relationship between ESG, tail risk, and upside potential of stocks before and during the COVID-19 crisis. *Finance Research Letters*, *46*, 102499. https://doi.org/10.1016/j.frl.2021.102499

MacKinlay, A. C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature*, *35*(1), 13–39.

Market Insider. (2023, May 25). *Crude Oil Price Today | BRENT OIL PRICE CHART | OIL PRICE PER BARREL | Markets Insider*. Markets.Businessinsider.Com. https://markets.businessinsider.com/commodities/oil-price

Mayberry, K., Child, D., & Marsi, F. (2022, February 23). *Latest Ukraine updates: Ukraine imposes state of emergency | Russia-Ukraine war News | Al Jazeera*. https://www.aljazeera.com/news/2022/2/23/not-peacekeepers-at-all-un-chief-condemns-russia-move-live

MSCI. (2023). *MSCIEurope Index*.

NATO. (2022, January 24). *NATO Allies send more ships, jets to enhance deterrence and defence in eastern Europe*. NATO. https://www.nato.int/cps/en/natohq/news_191040.htm

Ozili, P. K. (2022). *Global Economic Consequence of Russian Invasion of Ukraine* (SSRN Scholarly Paper No. 4064770). https://doi.org/10.2139/ssrn.4064770 perez, L., Hunt, V., Samandari, H., Nuttall, R., & Biniek, K. (2022). *Does ESG really matter—And why?* https://www.mckinsey.com/capabilities/sustainability/our-insights/does-esg-really-matter-and-why#/

Peterson, P. P. (1989). Event Studies: A Review of Issues and Methodology. *Quarterly Journal of Business and Economics*, *28*(3), 36–66.

Ray, M. (2023, May 6). *Ukraine crisis | Ukrainian history [2013-2014] | Britannica*. https://www.britannica.com/topic/Ukraine-crisis

Refinitiv. (2021, March 4). *ESG data | Refinitiv*. https://solutions.refinitiv.com/esg-data?utm_content=Refinitiv%20Brand%20Product-OTHER-EMEA-B-EN-Phrase&utm_medium=cpc&utm_source=bing&utm_campaign=748913_ESGBrandProductPaidSearch2023&elqCampaignId=20656&utm_term=%22refinitiv%20esg%22&s_kwcid=AL!11396!10!80127008818646!80127185460463&gclid=933cbb8d6c6313d2258bdfe5a9ea6d02&gclsrc=3p.ds&msclkid=933cbb8d6c6313d2258bdfe5a9ea6d02

Refinitiv. (2022). *ESG Scores*. https://www.refinitiv.com/en/sustainable-finance/esg-scores

Reuters. (2022, March 1). Timeline: The events leading up to Russia's invasion of Ukraine. *Reuters*. https://www.reuters.com/world/europe/events-leading-up-russias-invasion-ukraine-2022-02-28/

Riskoptics. (2021, November 12). *What Is ESG in Risk Management?* RiskOptics. https://reciprocity.com/resources/what-is-esg-risk-management/

Russia-Ukraine war 2022-2023. (2023, April 26). Statista. https://www.statista.com/topics/9087/russia-ukraine-war-2022/

Sankar, A. (2022, February 25). *KT explains: Why is Ukraine important to Russia? - News | Khaleej Times*. https://www.khaleejtimes.com/asia/kt-explains-why-is-ukraine-important-to-russia

Segund, W. (2021, December 7). *Governance Risks: Reshaping the 'G' in ESG*. https://www.auditboard.com/blog/governance-risks-esg/

Shafer, M., & Szado, E. (2018). *Environmental, Social, and Governance Practices and Perceived Tail Risk* (SSRN Scholarly Paper No. 3220617). https://doi.org/10.2139/ssrn.3220617

The Moscow Times. (2022, January 25). *Russian Troops, Jets Stage Drills Near Ukraine Amid High Tensions With West*. The Moscow Times. https://www.themoscowtimes.com/2022/01/25/russian-troops-jets-stage-drills-near-ukraine-amid-high-tensions-with-west-a76149

U.S. Ebassy. (2022, March 8). *FACT SHEET: United States Bans Imports of Russian Oil, Liquefied Natural Gas, and Coal*. U.S. Embassy & Consulates in the United Kingdom. https://uk.usembassy.gov/news-fact-sheet-united-states-bans-imports-of-russian-oil-liquefied-natural-gas-and-coal/

Vlamis, kelsey. (2022, February 25). *Why is Russia attacking Ukraine? Here are 5 reasons Putin and others have given for the invasion*. Yahoo News. https://news.yahoo.com/why-russia-attacking-ukraine-5-035515249.html

Wright, T. (2019). *What Is Managerial Opportunism?* Azcentral. https://yourbusiness.azcentral.com/managerial-opportunism-26607.html

Xia, Y. (2020). *Mann-Whitney U Test—An overview | ScienceDirect Topics*. https://www.sciencedirect.com/topics/biochemistry-genetics-and-molecular-biology/mann-whitney-u-test

Zumente, I., & Lāce, N. (2021). ESG Rating—Necessity for the Investor or the Company? *Sustainability*, *13*(16), Article 16. https://doi.org/10.3390/su13168940

9 APPENDIX

9.1 A : LIST OF SAMPLE FIRMS

#	Company Name	Ticker	Refinitiv Industry Category	Refinitiv ESG score
1	OMV AG	OMV_VI	Oil & Gas company	85
2	Neste Oyj	NESTE_HE	Oil & Gas company	79
3	Hellenic Petroleum S.A.	ELPE_AT	Oil & Gas company	57
4	Motor Oil Hellas	MOH_AT	Oil & Gas company	77
5	Rubis SCA	RUI_PA	Oil & Gas company	73
6	TotalEnergies SE	TTE_PA	Oil & Gas company	83
7	Galp Energia, SGPS, S.A.	GALP_LS	Oil & Gas company	74
8	Repsol SA	REP_MC	Oil & Gas company	87
9	Tethys Oil AB	TETY_ST	Oil & Gas company	33
10	Eni SpA	ENI_MI	Oil & Gas company	84
11	Saras S.p.A	SRS_MI	Oil & Gas company	56
12	Maha Energy AB	7M7_F	Oil & Gas company	28
13	Aker BP ASA	AKRBP_OL	Oil & Gas company	70
14	DNO ASA	DNO_OL	Oil & Gas company	27
15	Equinor ASA	EQNR_OL	Oil & Gas company	79
16	BP PLC	BP_L	Oil & Gas company	90
17	Capricorn Energy PLC	CNE_L	Oil & Gas company	72
18	Energean PLC	ENOG_L	Oil & Gas company	71
19	Enwell Energy PLC	ENW_L	Oil & Gas company	12
20	Genel Energy PLC	GENL_L	Oil & Gas company	52
21	Harbour Energy PLC	HBR_L	Oil & Gas company	50
22	Hurricane Energy PLC	HUR_L	Oil & Gas company	35
23	Nostrum Oil & Gas PLC	NOG_L	Oil & Gas company	45

24	NWF Group PLC	NWF_L	Oil & Gas company	23
25	Sound Energy PLC	SOU_L	Oil & Gas company	12
26	Serica Energy PLC	SQZ_L	Oil & Gas company	58
27	Tullow Oil PLC	TLW_L	Oil & Gas company	67
28	Shell PLC	SHEL_L	Oil & Gas company	93
29	EnQuest PLC	ENQ_L	Oil & Gas company	49
30	Schoeller-Bleckmann Oilfield Equipment	SBO_VI	Oil & Gas Related Equipment and Services	54
31	Euronav NV	EURN_BR	Oil & Gas Related Equipment and Services	58
32	Expro Group Holdings NV	FK2_DU	Oil & Gas Related Equipment and Services	80
33	CGG SA	CGG_PA	Oil & Gas Related Equipment and Services	74
34	Fugro NV	FUR_AS	Oil & Gas Related Equipment and Services	75
35	Koninklijke Vopak N.V.	VPK_AS	Oil & Gas Related Equipment and Services	73
36	Concordia Maritime AB	CCOR_B_ST	Oil & Gas Related Equipment and Services	45
37	Saipem SpA	SPM_MI	Oil & Gas Related Equipment and Services	84
38	Prosafe SE	1Q6_F	Oil & Gas Related Equipment and Services	66
39	Aker Solutions ASA	AKSO_OL	Oil & Gas Related Equipment and Services	72
40	BW Offshore Limited	BWO_OL	Oil & Gas Related Equipment and Services	64
41	Odfjell Drilling Ltd	ODL_OL	Oil & Gas Related Equipment and Services	67
42	PGS ASA	PGS_OL	Oil & Gas Related Equipment and Services	70
43	Subsea 7 SA	SUBC_OL	Oil & Gas Related Equipment and Services	76
44	TGS ASA	TGS_OL	Oil & Gas Related Equipment and Services	76
45	Petrofac Ltd	PFC_L	Oil & Gas Related Equipment and Services	78
46	Hunting PLC	HTG_L	Oil & Gas Related Equipment and Services	53
47	John Wood Group PLC	WG_L	Oil & Gas Related Equipment and Services	71
48	Tecnicas Reunidas SA	TRE_MC	Oil & Gas Related Equipment and Services	78
49	Petro Welt Technologies AG	O2C_DE	Oil & Gas Related Equipment and Services	26
50	TechnipFMC PLC	FTI	Oil & Gas Related Equipment and Services	69
51	SBM Offshore NV	SBMO_AS	Oil & Gas Related Equipment and Services	70
52	NWF Group PLC	S6W_F	Oil & Gas Transportation Services	25

53	Lubelski Wegiel Bogdanka SA	UXX_F	Coal company	46
54	ABO wind AG	AB9_DE	Renewable Energy company	25
55	CropEnergies AG	CE2_DE	Renewable Energy company	57
56	PNE AG	PNE3_DE	Renewable Energy company	35
57	Verbio Vereinigte BioEnergie AG	VBK_DE	Renewable Energy company	59
58	Vestas Wind Systems A/S	VWS_CO	Renewable Energy company	74
59	Scandinavian Biogas Fuels International AB	BIOGAS_ST	Renewable Energy company	36
60	nordex	NDX1_DE	Renewable Energy Equipment & Services	79
61	Acciona S_A	ANA_MC	Renewable Energy Equipment & Services	88
62	verbund	VER_VI	Electric Utilities & IPPs company	77
63	Encavis AG	ECV_DE	Electric Utilities & IPPs company	46
64	EnviTec Biogas AG	ETG_DE	Electric Utilities & IPPs company	10
65	Neoen SA	NEOEN_PA	Electric Utilities & IPPs company	53
66	Voltalia SA	VLTSA_PA	Electric Utilities & IPPs company	56
67	Boralex	BLX_TO	Electric Utilities & IPPs company	55
68	Ørsted A/S	ORSTED_CO	Electric Utilities & IPPs company	76
69	Endesa S_A	ELE_MC	Electric Utilities & IPPs company	88
70	Iberdrola SA	IBE_MC	Electric Utilities & IPPs company	84
71	Solaria Energía y Medio Ambiente, S.A	SLR_MC	Electric Utilities & IPPs company	59
72	Scatec ASA	SCATC_OL	Electric Utilities & IPPs company	61
73	EDP Renováveis SA	EDPR_LS	Electric Utilities & IPPs company	80
74	SSE PLC	SSE_L	Electric Utilities & IPPs company	85
75	E.ON SE	EOAN_DE	Multiline Utilities company	77
76	Electricité de France S.A.	EDF_PA	Multiline Utilities company	74
77	Engie SA	ENGI_PA	Multiline Utilities company	81

9.2 B: EVENT STUDY RESULTS DURING THE BUILD-UP AND CONTINUATION PERIOD.

Table B1 trough B10 displays the daily Average Abnormal Returns for the five distinct portfolios (All_Firms, High_ESG, Low_ESG, Renewable and Non_Renewable throughout the Build-up and Continuation period. The tables also display the Cumulative Average Abnormal Returns (CAAR) for the entire event window, highlighted in blue. The test statistics for both daily AAR and CAAR, derived from the two-sided crude adjusted t-test, are shown in the T-test column, while the Corrado test statistics are displayed in the Corrado column. The respective significance levels for both tests are also provided next to their corresponding test statistics. The "NoFirms" column display the number of firms in the portfolio of interest.

9.2.1 B1: ARR and CAAR for All_firms portfolio during Build-up period

Group	*t*	*NoFirms*	*AAR (CAAR)*	*T-test*	*T-test significance*	*Corrado*	*Corrado significance*
all firms	0	77	-0,01228	-2,73246	***	-0,94196	
all firms	1	77	0,00839	1,99197	**	1,30347	
all firms	2	77	0,02118	5,00003	***	2,27100	**
all firms	3	77	-0,01832	-4,23470	***	1,03425	
all firms	4	77	-0,00706	-1,69260	*	-0,86379	
all firms	5	77	-0,01220	-2,88779	***	-0,93021	
all firms	6	77	-0,00377	-0,89667		-0,46290	
all firms	7	77	-0,00674	-1,61038		-1,13770	
all firms	8	77	-0,00872	-2,07442	**	-1,28289	
all firms	9	77	0,02282	5,46904	***	1,82662	*
all firms	10	77	-0,00876	-2,08396	**	-1,32815	
all firms	11	77	-0,00827	-1,98229	**	-1,27995	
all firms	12	77	0,00525	1,24399		0,35474	
all firms	13	77	-0,00288	-0,67600		0,01029	
all firms	14	77	0,00988	2,36730	**	1,47746	
all firms	15	77	0,00492	1,14038		0,32653	
all firms	16	77	-0,01358	-3,21584	***	-0,95607	
all firms	17	77	0,01623	3,90683	***	1,73903	*
all firms	18	77	0,00154	0,36952		-0,25246	
all firms	19	77	-0,00335	-0,80291		-0,46701	
all firms	20	77	-0,00394	-0,94032		-0,80089	
all firms	[0;20]	77	-0,01967	-0,95332		-0,07869	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

9.2.2 B2: ARR and CAAR for High_ESG portfolio during Build-up period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
High ESG	0	39	-0,00240	-0,44065		0,03022	
High ESG	1	39	0,01380	2,78296	***	1,09325	
High ESG	2	39	0,01985	3,96973	***	2,01585	**
High ESG	3	39	-0,03802	-7,34442	***	1,39456	
High ESG	4	39	-0,01298	-2,65777	***	-1,11991	
High ESG	5	39	-0,02183	-4,37048	***	-1,55810	
High ESG	6	39	-0,00457	-0,92353		-0,55285	
High ESG	7	39	-0,00536	-1,08933		-0,80261	
High ESG	8	39	-0,00820	-1,65838	*	-1,12258	
High ESG	9	39	0,02536	5,18965	***	1,75276	*
High ESG	10	39	-0,00935	-1,89033	*	-1,19013	
High ESG	11	39	-0,00349	-0,71545		-0,86571	
High ESG	12	39	0,00465	0,93531		0,41241	
High ESG	13	39	-0,00310	-0,61171		0,00000	
High ESG	14	39	0,01417	2,90093	***	1,64965	*
High ESG	15	39	0,00096	0,18748		0,25065	
High ESG	16	39	-0,01170	-2,35383	**	-1,17591	
High ESG	17	39	0,01608	3,31653	***	1,57499	
High ESG	18	39	-0,00379	-0,77586		-0,36353	
High ESG	19	39	0,00366	0,74955		0,32975	
High ESG	20	39	0,00079	0,16051		-0,43019	
High ESG	[0;20]	39	-0,02548	-0,97742		0,77288	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

9.2.3 B3: ARR and CAAR for Low_ESG portfolio during Build-up period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Low ESG	0	38	-0,02242	-3,12078	***	-2,27089	**
Low ESG	1	38	0,00283	0,41341		1,37030	
Low ESG	2	38	0,02254	3,27675	***	2,21400	**
Low ESG	3	38	0,00191	0,27332		0,26435	
Low ESG	4	38	-0,00099	-0,14565		-0,29071	
Low ESG	5	38	-0,00232	-0,33819		0,23659	
Low ESG	6	38	-0,00295	-0,43153		-0,22966	
Low ESG	7	38	-0,00816	-1,19718		-1,43275	
Low ESG	8	38	-0,00925	-1,35275		-1,27594	
Low ESG	9	38	0,02022	2,96975	***	1,57568	
Low ESG	10	38	-0,00816	-1,19219		-1,27733	
Low ESG	11	38	-0,01317	-1,93489	*	-1,67004	*
Low ESG	12	38	0,00587	0,85471		0,19358	
Low ESG	13	38	-0,00264	-0,38478		0,02428	
Low ESG	14	38	0,00547	0,80358		0,91238	
Low ESG	15	38	0,00898	1,28790		0,37952	
Low ESG	16	38	-0,01550	-2,25747	**	-0,42115	
Low ESG	17	38	0,01637	2,41269	**	1,64645	*
Low ESG	18	38	0,00701	1,03058		-0,02845	
Low ESG	19	38	-0,01053	-1,54850		-1,61731	
Low ESG	20	38	-0,00878	-1,28721		-1,21905	
Low ESG	[0;20]	38	-0,01370	-0,42264		-0,63636	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

9.2.4 B4: ARR and CAAR for Renewable portfolio during Build-up period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Renewable	0	20	-0,00670	-1,22494		-0,25430	
Renewable	1	20	-0,00558	-1,07033		-0,58314	
Renewable	2	20	0,00961	1,83575	*	0,90905	
Renewable	3	20	0,01407	2,65189	***	1,20135	
Renewable	4	20	-0,00867	-1,67225	*	-0,65329	
Renewable	5	20	0,01531	2,93398	***	1,19989	
Renewable	6	20	-0,01385	-2,65673	***	-1,21450	
Renewable	7	20	-0,00403	-0,77581		-0,34053	
Renewable	8	20	-0,01720	-3,30411	***	-1,80203	*
Renewable	9	20	-0,00713	-1,37698		-0,91197	
Renewable	10	20	-0,00908	-1,74328	*	-1,15751	
Renewable	11	20	-0,00942	-1,81871	*	-0,80675	
Renewable	12	20	0,00897	1,71632	*	0,93974	
Renewable	13	20	-0,00729	-1,39303		-1,10635	
Renewable	14	20	-0,00860	-1,65853	*	-0,09792	
Renewable	15	20	0,00008	0,01553		-0,11546	
Renewable	16	20	0,01162	2,22219	**	1,29781	
Renewable	17	20	-0,00475	-0,92016		-0,39168	
Renewable	18	20	0,01037	2,00230	**	1,13412	
Renewable	19	20	-0,01276	-2,46390	**	-1,41619	
Renewable	20	20	-0,00703	-1,35275		-0,85790	
Renewable	[0;20]	20	-0,05204	-2,08625	**	-1,09710	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

9.2.5 B5: ARR and CAAR for Non-Renewable portfolio during Build-up period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Non-renewable	B	53	-0,01549	-2,51070	**	-0,89746	
Non-renewable	1	53	0,01440	2,49719	**	1,59876	
Non-renewable	2	53	0,02720	4,68783	***	1,93691	*
Non-renewable	3	53	-0,03373	-5,68724	***	0,30213	
Non-renewable	4	53	-0,00716	-1,25358		-0,62421	
Non-renewable	5	53	-0,02302	-3,97643	***	-1,30884	
Non-renewable	6	53	0,00028	0,04857		0,09674	
Non-renewable	7	53	-0,00830	-1,44759		-1,03558	
Non-renewable	8	53	-0,00627	-1,09026		-0,56943	
Non-renewable	9	53	0,03639	6,37053	***	2,32566	**
Non-renewable	10	53	-0,00926	-1,60788		-0,83852	
Non-renewable	11	53	-0,00850	-1,48873		-0,99629	
Non-renewable	12	53	0,00431	0,74569		0,02590	
Non-renewable	13	53	-0,00171	-0,29387		0,43429	
Non-renewable	14	53	0,01773	3,10346	***	1,52197	
Non-renewable	15	53	0,00777	1,31517		0,50812	
Non-renewable	16	53	-0,02428	-4,19895	***	-1,52316	
Non-renewable	17	53	0,02536	4,46133	***	1,94763	*
Non-renewable	18	53	-0,00257	-0,45018		-0,89210	
Non-renewable	19	53	-0,00010	-0,01770		0,05745	
Non-renewable	20	53	-0,00257	-0,44932		-0,35750	
Non-renewable	[0;20]	53	-0,00953	-0,33494		0,37369	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels.*

9.2.6 B6: ARR and CAAR for All_firms portfolio during the Continuation period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
all firms	0	77	-0,05625	-11,69673	***	-2,97972	***
all firms	1	77	0,00459	1,08328		0,94482	
all firms	2	77	0,00825	1,96068	*	0,50620	
all firms	3	77	-0,02334	-5,56417	***	-2,33582	**
all firms	4	77	-0,01396	-3,35334	***	-0,96277	
all firms	5	77	-0,01476	-3,22263	***	-1,96283	**
all firms	6	77	0,00823	1,96390	*	1,03961	
all firms	7	77	0,00305	0,73189		-0,12312	
all firms	8	77	0,01416	3,41414	***	1,42382	
all firms	9	77	0,00353	0,84213		0,15228	**
all firms	10	77	0,01309	3,07494	***	1,28191	
all firms	11	77	-0,00294	-0,70698		-0,16855	
all firms	12	77	0,01110	2,67675	***	0,85339	
all firms	13	77	0,00090	0,21485		-0,16686	
all firms	14	77	-0,03191	-7,40427	***	-2,66282	***
all firms	15	77	0,02176	5,16724	***	2,01219	**
all firms	16	77	0,01729	4,12160	***	2,07052	**
all firms	17	77	0,01514	3,64856	***	1,82990	*
all firms	18	77	0,00007	0,01783		-0,12648	
all firms	19	77	0,01750	4,16168	***	1,54609	
all firms	20	77	0,00933	2,21908	**	1,48944	
all firms	[0;20]	77	0,00483	0,25052		0,79882	

*AAR denotes the average abnormal return for firms on day t. CAAR is the cumulative average abnormal return throughout the event period. Significance levels are indicated by asterisks: *** for 99%, ** for 95%, and * for 90% confidence levels*

9.2.7 B7: ARR and CAAR for High_ESG portfolio during the Continuation period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
High ESG	0	39	-0,04999	-8,37294	***	-2,34834	**
High ESG	1	39	0,00445	0,89070		0,64459	
High ESG	2	39	0,00724	1,45641		0,19416	
High ESG	3	39	-0,02049	-4,15631	***	-1,82882	*
High ESG	4	39	-0,01428	-2,92962	***	-0,32798	
High ESG	5	39	-0,02207	-3,90485	***	-2,19615	**
High ESG	6	39	0,00949	1,92985	*	0,99006	
High ESG	7	39	-0,00151	-0,30853		-0,50640	
High ESG	8	39	0,01748	3,61208	***	1,42649	
High ESG	9	39	0,00098	0,19896		-0,02624	**
High ESG	10	39	0,00685	1,35617		0,57550	
High ESG	11	39	-0,00355	-0,72853		-0,40232	
High ESG	12	39	0,00996	2,05622	**	1,26731	
High ESG	13	39	-0,00317	-0,64963		-0,50553	
High ESG	14	39	-0,02342	-4,57119	***	-1,90228	*
High ESG	15	39	0,01528	3,07166	***	1,24457	
High ESG	16	39	0,01587	3,21775	***	1,69500	
High ESG	17	39	0,01445	2,98068	***	1,61803	*
High ESG	18	39	-0,01230	-2,50056	**	-1,00493	
High ESG	19	39	0,01783	3,59391	***	1,51833	
High ESG	20	39	0,00511	1,03344		1,11338	
High ESG	[0;20]	39	-0,02581	-1,116191		0,27025	

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9.2.8 B8: ARR and CAAR for Low_ESG portfolio during the Continuation period

Group	t	NoFirms	AAR (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Low ESG	0	38	-0,06267	-8,27162	***	-3,35589	***
Low ESG	1	38	0,00473	0,68704		1,21016	
Low ESG	2	38	0,00928	1,35950		0,86915	
Low ESG	3	38	-0,02627	-3,84576	***	-2,64831	***
Low ESG	4	38	-0,01364	-2,00728	**	-1,71339	*
Low ESG	5	38	-0,00725	-1,00125		-1,26253	
Low ESG	6	38	0,00694	1,01622		0,92151	
Low ESG	7	38	0,00773	1,13724		0,45916	
Low ESG	8	38	0,01075	1,58599		1,15780	
Low ESG	9	38	0,00615	0,90129		0,38508	
Low ESG	10	38	0,01950	2,82726	***	2,07867	**
Low ESG	11	38	-0,00232	-0,34151		0,20372	
Low ESG	12	38	0,01228	1,81165	*	0,09260	
Low ESG	13	38	0,00507	0,74533		0,35826	
Low ESG	14	38	-0,04063	-5,82646	***	-3,28564	***
Low ESG	15	38	0,02841	4,15522	***	2,76453	***
Low ESG	16	38	0,01875	2,74554	***	2,23960	***
Low ESG	17	38	0,01586	2,33856	**	1,80407	*
Low ESG	18	38	0,01278	1,87464	*	1,17951	
Low ESG	19	38	0,01716	2,51190	**	1,30340	
Low ESG	20	38	0,01366	1,99612	**	1,76575	*
Low ESG	[0;20]	38	0,03628	1,15586		1,42435	

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9.2.9 B9: ARR and CAAR for Renewable portfolio during the Continuation period

Group	t	NoFirms	AARE (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Renewable	0	20	-0,04766	-8,26544	***	-2,07046	**
Renewable	1	20	-0,00217	-0,41379		0,39850	
Renewable	2	20	0,00611	1,17507		0,84609	
Renewable	3	20	-0,02859	-5,49902	***	-1,95928	*
Renewable	4	20	-0,00711	-1,37599		-0,55010	
Renewable	5	20	-0,01111	-2,01632	**	-1,02224	
Renewable	6	20	0,00415	0,79728		0,15738	
Renewable	7	20	-0,00605	-1,16891		-0,88074	
Renewable	8	20	-0,01030	-1,99709	**	-0,94282	
Renewable	9	20	-0,00146	-0,28133		-0,11839	
Renewable	10	20	-0,00088	-0,16713		-0,42593	
Renewable	11	20	-0,00690	-1,33372		-0,11984	
Renewable	12	20	-0,00625	-1,21094		-0,50534	
Renewable	13	20	0,00989	1,91108	*	1,12330	
Renewable	14	20	-0,03532	-6,65577	***	-2,13543	**
Renewable	15	20	0,02782	5,34540	***	1,83078	*
Renewable	16	20	0,02263	4,35269	***	1,94629	*
Renewable	17	20	0,01007	1,95132	*	0,64684	
Renewable	18	20	0,00362	0,69839		0,33208	
Renewable	19	20	0,03186	6,12802	***	2,17586	**
Renewable	20	20	0,01709	3,28057	***	1,13774	
Renewable	[0;20]	20	-0,03057	-1,26505		-0,02962	

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9.2.10 B10. ARR and CAAR for Non-Renewable portfolio during the Continuation period

Group	t	NoFirms	AAR (CAAR)	T-test	T-test significance	Corrado	Corrado significance
Non-renewable	0	53	-0,06582	-9,95559	***	-2,51186	**
Non-renewable	1	53	0,00771	1,32920		0,84945	
Non-renewable	2	53	0,00942	1,63499		0,23568	
Non-renewable	3	53	-0,02298	-4,00050	***	-1,70331	**
Non-renewable	4	53	-0,01838	-3,22506	***	-0,95714	
Non-renewable	5	53	-0,01635	-2,59754	**	-1,53795	
Non-renewable	6	53	0,00931	1,62267		0,90888	
Non-renewable	7	53	0,00673	1,17900		0,25098	
Non-renewable	8	53	0,02542	4,47866	***	2,00813	**
Non-renewable	9	53	0,00475	0,82716		0,02207	
Non-renewable	10	53	0,02079	3,56297	***	1,73155	*
Non-renewable	11	53	-0,00088	-0,15450		0,01089	
Non-renewable	12	53	0,01885	3,31975	***	1,11779	
Non-renewable	13	53	-0,00258	-0,45192		-0,67938	
Non-renewable	14	53	-0,03342	-5,65949	***	-2,00401	**
Non-renewable	15	53	0,02090	3,62322	***	1,35847	
Non-renewable	16	53	0,01705	2,96791	***	1,47204	
Non-renewable	17	53	0,01868	3,2886	***	1,75921	**
Non-renewable	18	53	-0,00107	-0,18610		-0,24039	
Non-renewable	19	53	0,01356	2,35556	**	0,82944	
Non-renewable	20	53	0,00680	1,18065		1,02069	
Non-renewable	[0;20]	53	0,01850	0,69747		0,85993	

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