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Stock Market Reaction of European Defense Firms to the Russia-Ukraine War: An event Study Approach

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ABSTRACT :
The war has always forced financial markets to face the consequences of a new reality. Thus, the impact of geopolitical shocks and their implications for financial markets have become a growing focus in academic research. Studies have already examined energy markets, government spending, international trade, aggregate spending, and overall stock market performance. However, there are few studies that specifically analyze the stock market reaction of European defense firms in the wake of a major geopolitical conflict. This paper analyzes the effect of the Russia Ukraine war, which started with the full-scale invasion of Ukraine on 24 February 2022, on the stock returns of publicly traded European defense companies.

The research theoretical framework is constructed on the basis of the Efficient Market Hypothesis, Asset Pricing Theory, and Modern Portfolio Theory with particular emphasis on the expected cash flow hypothesis, according to which defense companies may benefit from geopolitical conflict due to the expected rise in military spending by the government. The framework also relies on the event study methodology as the main empirical methodology to determine abnormal stock market responses to discrete geopolitical events.

The data for the study consists of daily stock returns of 16 European defense companies chosen in the Stockholm International Peace Research Institute Arms Industry Database between February 2021 and March 2022. Market index data and stock prices are obtained from the Refinitiv Eikon database, and factor data are sourced from the Kenneth French Data Library. The event study methodology is applied in the empirical section of the study with both the Market Model and the Carhart Four-Factor Model.

The findings of this study show that the outbreak of Russian-Ukraine war resulted in a major and significant positive market response in the European defense market, consistent with the cash flow hypothesis. The results show that European defense companies had positive abnormal returns on the date of the event and on event windows that were wider and the effect was sustained and increased as the trading period surrounding the event. These findings are the same in both model specifications, indicating that the observed reaction is due to a geopolitical event effect and not due to exposure to typical systematic risk factors.

KEYWORDS: Geopolitical risk, Event study, Defense industry, Stock returns, Russia-Ukraine war, Abnormal returns

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Abbreviations

AAR	=	Average Abnormal Return
AR	=	Abnormal Return
CAAR	=	Cumulative Average Abnormal Return
CAC	=	Cotation Assistée en Continu (French stock market index)
CAPM	=	Capital Asset Pricing Model
CAR	=	Cumulative Abnormal Return
CSI	=	China Securities Index
E-GARCH	=	Exponential Generalized Autoregressive Conditional Heteroskedasticity
E7	=	Emerging 7 Economies
EGARCH-X	=	Exponential Generalized Autoregressive Conditional Heteroskedasticity with Exogenous Variables
EMH	=	Efficient Market Hypothesis
FF4	=	Carhart Four-Factor Model
FMOLS	=	Fully Modified Ordinary Least Squares

FTSE	=	Financial Times Stock Exchange
G7	=	Group of Seven
GARCH	=	Generalized Autoregressive Conditional Heteroskedasticity
GDP	=	Gross Domestic Product
GMM	=	Generalized Method of Moments
GPR	=	Geopolitical Risk
GSDAF	=	Generalized Supremum Augmented Dickey-Fuller
MM	=	Market Model
MSCI	=	Morgan Stanley Capital International
MPT	=	Modern Portfolio Theory
NATO	=	North Atlantic Treaty Organization
OLS	=	Ordinary Least Squares
OTC	=	Over-the-Counter
PCO	=	Principal Component Analysis
QQR	=	Quantile-on-Quantile Regression
QVAR	=	Quantile Vector Autoregression
SADF	=	Supremum Augmented Dickey-Fuller
T-GARCH	=	Threshold Generalized Autoregressive Conditional Heteroskedasticity
TASE	=	Tel Aviv Stock Exchange
TVP-VAR	=	Time-Varying Parameter Vector Autoregression
UAE	=	United Arab Emirates
UK	=	United Kingdom
U.S.	=	United States

1 Introduction

Financial markets are highly sensitive to unexpected global events, particularly those that increase uncertainty and risk. Among these, geopolitical conflicts and wars are significant shocks, as they interfere in economic activity, affect the policy of the government and investor expectations. Geopolitical tensions have been on the rise in recent years, and the Russia-Ukraine war of 2022 became one of the most crucial events that impacted the European economies and financial markets.

The effects of geopolitical shocks are, however, not felt equally in all industries. Although the general market tends to respond adversely, certain sectors tend to be more vulnerable as they are dependent on international trade and economic stability, and others might gain advantages in such circumstances. One of the obvious examples of the latter is the defense industry. Defense companies are highly linked to the government expenditure and when there is a conflict, military expenditures and long-term procurement contracts are likely to increase. These may cause investors to re-price their expectations higher, causing stock market behavior that is not consistent with the market at large.

Although the literature on geopolitical risk and financial markets has been on the rise, comparatively little has been done on sector-specific responses, especially in Europe. The majority of the literature is on aggregate market indices or international samples, and there is a gap in the knowledge of how European defense companies respond to significant geopolitical events. This gap is especially relevant given Europe’s direct exposure to the Russia–Ukraine war and the subsequent increase in defense spending across the region.

Against this background, this study aims to analyze the stock market performance of European defense companies in reaction to the Russia-Ukraine war. The analysis is performed with the help of an event study approach, with an emphasis on the abnormal returns around the date of the invasion 24 February 2022. Focusing on a particular industry and a geographic setting, the given research will help to gain a better insight into the reaction of financial markets to geopolitical shocks and whether defense stocks have a different response to conflicts.

1.1 Background and Motivation

Russia invaded Ukraine on 24 February 2022. This was a major and unforeseen event in Europe. The news had an instant impact on financial markets. Share prices dropped, commodity prices spiked and there was a lot of uncertainty about what would happen next. The invasion caused problems for businesses and countries throughout Europe, as the war had impacts on trade, energy and stability.

But the war has not affected all industries. Most industries were hurt because of the economic uncertainty and disruption. But not the defense industry. Defense firms earn their revenues from sales of arms and services to governments. Governments generally increase their defense spending in war. They purchase more equipment, boost their budgets and make plans to build up their forces. Investors know this. So, when war starts, investors expect defense companies to be able to make more profit. So, they will want to buy shares from these companies, driving up the share prices. Put simply, while most businesses lose money in a war, defense companies can make more money.

This is what happened after the invasion of Ukraine. Governments in Europe very quickly announced their intention to increase military spending. Defense spending in the European Union rose to a level of 240 billion in 2022 (European Defence Agency, 2022). Later, it reached 343 billion in 2024 (European Defence Agency, 2025). This was a very large and rapid increase. The investors reacted straight away and started to buy the shares of European defense companies in anticipation of the fact that these companies would generate more revenue in the future. This made the situation very different for defense stocks than for most other types of stocks, where prices were declining.

This study is motivated to find out if this positive effect on the stock prices of defense companies is evident or not. Although there have been many studies on the effects of the war on European stock markets overall, few have examined the effect on European defense companies. This is despite Europe's direct involvement in the war, and European governments' defense spending increases in the past few decades. This research seeks to address this issue by analysing the short-term market response of European defense stocks around the invasion.

1.2 Previous Main Studies

There has been a lot of research on the effects of geopolitical events on stock markets. The overall conclusion of this body of research is that uncertainty rises and stock markets react negatively to wars. Boungou and Yatié (2022) study the global stock indices during the Russia-Ukraine war and report that stock returns were reduced after the outbreak and were the most affected in countries close to the region. Izzeldin et al. (2023) concentrate on European markets and find that market volatility increased significantly after the invasion, confirming that European markets were strongly affected.

But the effects vary by industry. One industry that is likely to benefit from geopolitical conflict is the defense industry, as it is highly dependent on government defense spending. Apergis and Apergis (2016) find that major international defense corporations' stock prices have generated substantial positive returns following the 2015 Paris terrorist attacks. This is, they argue, due to the anticipated increased future demand for military services, or the flight-to-arms effect. More closely related to the current study, Martins et al. (2025) study the stock market return of the world's 100 largest listed defense firms after the invasion of Ukraine. They report positive and significant abnormal returns of 3.24% to 5.65% for the global sample. For their 20 European defense companies subsample, the portfolio cumulative abnormal returns vary from 2.38% to 10.54% in different event windows. Adnan et al. (2026) confirm these results by studying 370 defense and aerospace firms in 17 countries around the event date. They report an average abnormal return of 1.45% on the event date and a cumulative abnormal return of 5.74% over a seven-day period, with the largest reactions for firms from NATO countries.

By contrast, other industries exhibit negative responses to the war. Martins and Cró (2024) report substantial negative stock price reactions for European airline stocks because of travel restrictions and increased costs. Martins et al. (2023) find negative abnormal returns for European banking stocks because of financial exposure to Russia, and due to sanctions. This distinct reaction of the defense sector compared to other sectors further underlines the need for sector specific analysis and motivates the focus of the current research

1.3 Purpose of the Study

This study aims to explore the reaction of the stock prices of European defense companies to the Russia-Ukraine war. The research concentrates on the short-term response to the date of the invasion of Ukraine on 24 February 2022. The study adopts an event study approach to examine whether there were abnormal returns for European defense companies on the day of the event. The study uses two benchmark models to determine what the returns would be in the absence of the event: the Market Model and the Carhart Four-Factor Model. This way, the result might be consistent and are not dependent on the chosen benchmark model. Event windows vary from the day of the invasion to a 21-day symmetric event window of [−10, +10] to capture both the short- and long-term market reaction to the war.

The key research question of this paper is thus: what impact did the Russia-Ukraine war have on the stock returns of European defense companies? To answer this question, the study will look at three things. First, whether the invasion led to statistically significant abnormal returns for European defense companies. Second, if the response was concentrated on the event day or rather across a longer event window. Third, whether the results are robust to different model estimates and aggregations.

1.4 Development of the hypotheses

The hypothesis in this study is developed based on the theoretical relationship between new information and what previous research has shown about the responses of defense stocks to geopolitical events. According to the Efficient Market Hypothesis in its semi-strong form, stock prices reflect all publicly available information at any given time (Fama, 1970). If new and relevant information becomes available, stock prices will move rapidly to reflect that information. So, when a big event, such as the invasion of Ukraine, occurs, investors do not delay. They begin trading stocks immediately as they incorporate their expectations about the future cash flows of companies into stock prices.

This theory is also supported by asset pricing theory. The Capital Asset Pricing Model (Sharpe, 1964) and its extensions like the Fama-French Three-Factor Model (Fama and French, 1993) and the Carhart Four-Factor Model (Carhart, 1997) imply that the price of a stock is the present value of its expected cash flows. Anything that affects investors' expectations of a company's future earnings will affect the company's stock price. If they expect it to earn more, its stock price goes down. If they expect it to earn less, its stock price goes down.

The empirical evidence on geopolitical risks such as wars and conflicts, do in general have a negative impact on stock markets. For example, Caldara and Iacoviello (2022) find that increased geopolitical risk leads to lower stock prices and reduces investment in the economy. This is also borne out in the case of the Russian invasion of Ukraine, where Boungou and Yatié (2022) report negative stock returns across the world in response to the invasion. This evidence confirms a negative reaction to the war's outbreak, with increasing uncertainty and negative sentiment among investors.

But the defense sector is in a different situation to the rest of the market. Defense companies generate their revenues from military contracts. In a time of war, governments are likely to boost their military spending and speed up the procurement process. This has implications for future revenues of defense firms. Investors are aware of this and react accordingly by investing in defense firms to bet on future earnings. In fact, past research shows that defense stocks do respond positively to these types of events, as investors anticipate increasing future demand and expenditure. This is in contrast to most other industries. This view is supported by the study of Apergis and Apergis (2016) showed that the positive returns for defence stocks for the 2015 terrorist attack. More relevant, Martins et al. (2025) and Adnan et al. (2026) find significant positive returns for defense stocks around the Ukraine invasion, confirming that investor responses to the start of the war were positive, evidenced by purchases of defense stocks in expectation of future increases in military expenditures. As such, these results demonstrate that the defense sector responds differently to geopolitical events than the overall market.

In the context of the Russia-Ukraine conflict, European defense companies are of particular interest. Europe is both a geographic and economic victim of the conflict. The invasion generated an expectation right away that European countries would ramp up their defense spending. This expectation was sufficient to cause investors to raise their expectations of the value of European defense stocks on and around the event date. This is how financial markets are supposed to operate - stock prices react to expectations of the future, not to events that are already known.

On this basis the study hypothesis is as follows:
H1: European defense firms experience positive abnormal returns around the invasion date of 24 February 2022.

This hypothesis predicts that once the invasion started, investors would begin to purchase European defense stocks, anticipating an increase in future defense budgets in Europe. This should increase the prices of European defense stocks relative to what they would otherwise have been, and result in positive and statistically significant abnormal returns on the event date.

1.5 Intended Contribution and Research Gap

While there is an emerging body of research on the subject of geopolitical risk and financial markets, there are still important gaps that the present study aims to address. These gaps need to be identified to justify the methodology of research design in this study and to understand the results in terms of the broader research conversation on geopolitical risk, defense economics and financial markets.

Firstly, the majority of the available literature studies stock market indices as a whole or multiple sectors, which are important but necessarily broad, in terms of the financial market responses to geo-political events. For instance, Boungou and Yatié (2022) examine stock returns of 94 countries and do not distinguish the sectors, so it is not possible to see how different sectors responded to the same event. Similarly, Hoffmann et al. (2025) study stock market reactions to 17 military invasions across the G7 and E7 markets, but do not separate them by industry. While these studies give the overall direction of the stock market reactions to geopolitical events, they cannot reveal the possible differentiated responses that may occur under the hood of aggregate indices. The present research addresses this shortcoming by focusing on the defense industry specifically, which provides a more specific picture of the response of a strategically important industry to a major geopolitical event.

Secondly, while there are studies that have focused on the defense industry in the Russia-Ukraine war, they are more likely to have a global or multi-regional sample. Martins et al. (2025) research the largest listed defense firms in the world (the top 100), and Adnan et al. (2026) study 370 defense and aerospace companies in 17 countries. While these studies provide important evidence on the global scale, the wide geographical coverage means that the special response of European defense firms, the firms that are the most exposed to the conflict by virtue of their geographical proximity, economic interdependence and the subsequent rise of European defense spendings, is not exceptional or detailed The proximity of Europe to the war between Russia and Ukraine make it a rather unique regional environment, and the current research fills this gap by constructing a sample of European defense companies in particular and their market response as a logical regional grouping.

Finally, the last gap is the non-use of multi-factor asset pricing models in investigating the abnormal returns of the defense sector around geopolitical events. The majority of the current event studies in this area use the Market Model as the benchmark model of expected returns and this can lead to the observed abnormal returns being affected by other systematic risk factors such as size, value and momentum. The current paper addresses this issue by using both Market Model and Carhart Four-Factor Model so that the calculated abnormal returns are robust to include the additional risk factors and that any reaction can be more justified by the geopolitical event and not the current factor exposures.

Based on the above-mentioned gaps, the contribution of this research paper can be outlined in four points. First, it offers a sector-specific point of view to the current body of literature on the financial impact of the Russia-Ukraine war, as it uses the defense sector and not market indices or multi-sector samples. Second, it makes a regional contribution in that it uses European defense companies as a specialized and relevant sample (in contrast to the studies that use global or multi-regional samples). Third, it is methodologically valuable, as it employs a sound event study design to a single, well-defined geopolitical event, making it possible to pinpoint the market reaction better than in the case of time-series or multiple events. Fourth, it offers a contribution in terms of empirical estimates using both the Market Model and the Carhart Four-Factor Model as benchmark models which makes the results less sensitive to specification changes and provides more reliable measures of abnormal returns than the studies that use a single benchmark model.

Overall, these contributions make the current study a regional, methodological, geopolitical risk-oriented, and a contribution to the growing literature on financial markets and geopolitical risk. The current study will fill in the gaps to provide a more accurate and refined understanding of financial markets' reaction to geopolitical events on the level of the sector, with the European defense sector in the context of the largest geopolitical event in Europe since the Second World War being particularly important.

1.6 Limitations and Assumptions

While this study provides important insights, there are some limitations that need to be taken into account. First, the study does not provide information on the long-term effects of the war on the performance and valuation of European defense stocks because it focuses only on the short-term event window of [−10, +10]. Consequently, the findings should be understood in terms of short-term market responses, rather than long-term market valuations.

Second, the research is based on a single geopolitical event. Although the Russia-Ukraine war is a major and clear-cut event, the market reaction to this event may be unique to this specific event and not generalizable to the response of the defense sector to geopolitical tensions. As such, care should be taken when drawing inferences for smaller events or with different geographical and economic properties.

Third, the event window is likely to be influenced by other macroeconomic factors. The invasion occurred at a time when inflation was increasing, interest rates were tightening and energy prices were fluctuating. While the estimation window helps to control overall market factors, it is not possible to fully disentangle the effects of the war from these factors.

Fourth, the data sample is restricted to 16 public European defense firms, and does not include private, government-owned, and smaller unlisted contractors. This could affect the generalization of the results for the European defense industry as a whole. Furthermore, while the Carhart risk factors were translated into Euros from US Dollars, possible fluctuations in the exchange rate during the event period may have had a small effect on the values of the factors, which may partly account for the slightly higher abnormal return estimates using the Carhart model.

As for assumptions, this paper assumes that financial markets are semi-strong-form efficient, with stock prices reflecting all publicly available information and quickly responding to new information (Fama, 1970). This is a key assumption of the event study approach and suggests that the abnormal returns around the event date are a result of the information shock associated with the invasion. Another assumption of this study is that the Market Model and the Carhart Four-Factor Model are suitable models for computing the expected return. Both models are well established and extensively used, but no asset pricing model is able to explain all market risks, especially during a crisis. By employing two model specifications, this study partially overcomes this limitation by showing that results are robust to changes in the benchmark models. Although these limitations and assumptions do not affect the validity of the results, they limit the scope in which the findings can be interpreted and where future research could build on the analysis.

1.7 Structure of the Thesis

This thesis is organized into seven chapters. Chapter 1 introduces the research topic and provides the background and motivation for the study, along with a review of previous main studies, the purpose of the research, research questions, hypotheses, and the overall contribution, limitations, and structure of the thesis. Chapter 2 presents a review of the relevant literature on geopolitical risk, financial markets, and the impact of wars on stock returns, with a particular focus on the defense industry and the Russia–Ukraine war. Chapter 3 outlines the theoretical framework, including the Efficient Market Hypothesis, asset pricing theory, and geopolitical risk theory, which together explain how financial markets respond to major geopolitical events. Chapter 4 describes the data and methodology used in the study, including sample selection, data sources, event study design, and the models applied to estimate abnormal returns, namely the market model and the Carhart four-factor model. Chapter 5 presents the empirical results, including descriptive statistics, abnormal return analysis. Chapter 6 discusses the findings in relation to existing literature and highlights their implications for investors and policymakers. Finally, Chapter 7 concludes the thesis by summarizing the key findings and suggesting directions for future research.

2 Literature Review

This chapter is a review of literature on the correlation between geopolitical risk and financial markets, especially the role of wars and conflicts in influencing stock market performance. The review starts with a discussion of the impact of geopolitical risk on financial markets in general and then proceeds to studies that specifically analyse stock market responses to war-related events. Next, the chapter dwells on the sectoral differences, specifically, the defense industry, which is likely to react to geopolitical shocks differently since it is tightly connected with government spending. Lastly, the chapter examines the recent empirical evidence on the financial market effect of the Russia-Ukraine war.

2.1 Geopolitical Risk and Financial Markets

The connection between geopolitical risk and financial markets has been the subject of increasing scholarly interest, especially with the emergence of systematic instruments to measure geopolitical uncertainty. The articles discussed in this section all indicate that geopolitical risk is not a temporary market shock but a long-term phenomenon that can transform investment behaviour, cause cross-market volatility spillovers, and can create structural changes in equity markets of various regions and sectors.

Caldara and Iacoviello (2022) make a fundamental contribution to this literature by building a news-based measure of geopolitical risk (GPR) that has since become the tool of quantifying geopolitical uncertainty in empirical literature. They rely on about 25 million articles published in ten major English-language newspapers between 1900 and the present to conduct an automated text-search algorithm to trace the frequency of words that are associated with war, terrorism, and diplomatic tensions. One of the major contributions of the study is the differentiation between geopolitical acts actualized events like the beginning of war and geopolitical threats, the expectation of such events which are both found to be independent predictors of economic activity declines. Their results show that high geopolitical risk causes sustained declines in investment, employment, and stock prices, and increases the likelihood of more general declines in the economy. Instead of directly taking the GPR index, the current thesis considers the outbreak of the war in Russia-Ukraine as a unique geopolitical event and quantifies its effect on European defense stocks in terms of abnormal returns, applying the market model and the Fama-French four-factor model to isolate event-driven price responses.

Khraiche et al. (2023) investigate the long-term impact of geopolitical risk on the development of stock markets based on the results of 37 countries, 1975-2019. They quantify geopolitical risk based on the GPR index created by Caldara and Iacoviello (2022) and market development in terms of stock market capitalization as a fraction of gross domestic product (GDP). Their results show a strong and consistent negative relationship between higher geopolitical risk and smaller stock markets. The authors contend that this is done primarily by investment, as geopolitical risk increases, anticipated profits decline and it becomes more challenging to borrow, thus making it harder to list firms on stock exchanges. They also conclude that real conflict events like wars are worse in market development as compared to the threat of conflict. North American and European markets have been observed to be more susceptible to geopolitical shocks than Asian markets, due to the fact that the Western financial systems are more dependent on equity markets, as opposed to banks. The results can be applied to the current research, because they indicate that European stock markets are especially vulnerable to the type of geopolitical shock that the war between Russia and Ukraine has brought about.

Banerjee et al. (2024) study the transmission of volatility through financial markets by geopolitical risk, and the study is based on a time-varying parameter vector autoregression (TVP-VAR) framework, which models a spillover network comprising stocks, bonds, the US dollar, gold, and energy markets. They analyze three separate periods: the long-term horizon, the COVID-19 pandemic, and the Russia-Ukraine war and conclude that military conflicts produce much greater cross-market risk spillovers than health crises. Geopolitical risk is found to be a net transmitter of shocks, which propagates instability in markets, and the bond market and coal also prove to be significant agents of volatility transmission. It is important to note that gold is observed to be a net recipient of shocks in times of military build-up, which questions its traditional reputation as a safe-haven asset, and casts doubt on its usefulness in portfolio diversification.

In a study by Korsah and Mensah (2024), the authors investigate the spillovers and explore the connection between geopolitical risk, economic policy uncertainty, and financial stress on seven African stock markets. Using monthly data from May 2007 to April 2023, through a Quantile Vector Autoregression (QVAR) model to capture how these relationships vary across bearish, normal and bullish market conditions. The results indicate that risk spillovers are more pronounced in extreme market conditions, with financial stress being the dominant driver under normal and bullish conditions, while geopolitical risk takes over as the primary shock transmitter during bearish periods. The paper also finds that there is significant heterogeneity among African exchanges with the Egyptian Exchange and the Nairobi Securities Exchange being the most susceptible to external shocks with the Johannesburg Stock Exchange and others being more resilient. Overall, the study challenges the decoupling hypothesis, showing that emerging markets remain exposed to global shocks such as the Russia-Ukraine war. Although the geographical scope of this research is not the same as the European market discussed in the current thesis, the results support the overall argument that geopolitical risk may severely affect equity markets, especially in times of greater uncertainty.

Kotsompolis et al. (2025) study the connection between geopolitical risk, market uncertainty, and European equity returns, specifically in the energy sector. They use daily data between March 2013 and March 2024 to estimate Markov Switching models and frequency domain spectral causality tests to estimate regime-specific dynamics during major crisis periods, such as the Russia-Ukraine war and the Israel-Palestine conflict. Their results indicate that geopolitical threats positively impact stock returns in low-return market conditions with a statistically significant impact, which implies that in the case of extreme uncertainty, investors can shift portfolios towards some European stocks that are viewed as relatively resistant. Another important indicator of more general changes in economic activity that influence equity performance, identified in the study, is the volatility of energy markets. The results are directly applicable to the current thesis, as they affirm that the Russia-Ukraine war was a trigger of the regime changes in the European equity markets and indicate that the strategic sectors, including defense, could serve as hedges in the times of increased geopolitical instability.

Singh and Roca (2022) study the impact of China-specific geopolitical risk on the returns and volatility of the Canadian stock market and its sectors. They estimate volatility with a GARCH (1,1) model and use a fully modified ordinary least squares (FMOLS) model to control serial correlation and endogeneity using monthly data between April 2000 and December 2018. Their findings indicate that the geopolitical risk of China has a strong and long-lasting negative effect on the national stock index of Canada, and its effects are stronger than those of general geopolitical risks in the world. At the sector level, the resources and energy sectors are recognized to be the most susceptible to this as they are highly dependent on the Chinese demand in the commodity boom that occurred between 2000 and 2011. These results are applicable to the current thesis because they indicate that industry-specific trade relationships and interdependencies determine the strength of market reactions to geopolitical shocks - a phenomenon that can be applied to European defense stocks, whose prices are strongly associated with military-strategic demand in the context of the Russia-Ukraine conflict.

2.2 War and Stock Market Reactions

Ijaz et al. (2025) discusses the short-term economic effects of the 2023 Palestine-Israel war on the global asset markets, such as equities, energy, metals, and cryptocurrencies. They determine October 9, 2023, as the event date (the first trading day after the weekend increase) and an 11-day event window of [-5, +5] with a 113-day estimation period to compute abnormal returns using daily data and an event study design with the MSCI World Index as the benchmark. They find that equity markets in Germany, the UAE, Bahrain and Kuwait had large negative abnormal returns on the event day, which were caused by regional proximity and economic interconnectedness with the conflict region. Energy markets, however, registered positive abnormal returns as the investors factored in the fears of supply disruptions and gold reasserted its safe-haven status with positive post-event returns. The markets of cryptocurrencies were mostly not affected, except Ethereum, which responded strongly negatively. Overall, the authors conclude that the effect of war on financial markets depends on both regional exposure and the type of asset which shows the importance of diversification during geopolitical crises.

Pandey et al. (2024) investigate the question of whether national happiness levels affect the resilience of stock markets to geopolitical shocks, with the 2023 Israel-Hamas conflict being their event. Using the MSCI All Country World Index as a benchmark, they analyze 71 stock market indexes around the world, using an event study methodology with an estimation window of 250 days and an event window of 15 days of [-7, +7]. In order to describe the cross-sectional variation in market responses, they regress cumulative abnormal returns (CAR) on World Happiness Report scores and condition on macroeconomic variables, including government debt, inflation, and geographic distance to the conflict. Their results indicate that although the conflict had a net adverse cumulative impact on world markets, indices of happier countries were much more resilient, indicating that societal well-being serves as a buffer to investor panic in the wake of geopolitical shocks. The outcomes of the regional heterogeneity show that the markets of EMEA were the most susceptible, and they had the strongest negative responses. Interestingly, the post-event CARs were positively correlated with government debt and inflation, which the authors attribute to the fact that investors perceived fiscal activity and established monetary policy to be indicative of stability in times of uncertainty. Although the scope of this research is not the same as the current thesis, its event study design and cross-sectional CAR analysis is a valuable methodological benchmark, and its conclusion that European markets are especially sensitive to geopolitical conflict further justifies the need to investigate European defense stocks in the context of the war between Russia and Ukraine.

Ahmed and Sleem (2025) discuss the impact of the public on stock market performance during the 2023 war between Israel and Palestine, in the context of the Tel Aviv Stock Exchange (TASE) on an aggregate and sectoral level. They build a war-related public attention index based on the Google Trends data on 20 conflict-related search terms using daily data between January 2023 and June 2024 and use Principal Component Analysis (PCA) to reduce the dimensions and obtain a more refined proxy of investor attention. They then use an EGARCH-X model to estimate the relationship between this measure of attention and stock returns and conditional volatility. Their results indicate that the negative returns and volatility in most sectors are always linked to the increased attention of the population to the conflict. The study also finds that the finance and technology sectors are more sensitive to war-related information, while sectors such as real estate and industrials show relatively lower impact.

Using daily data between 1990 and 2000, Schneider and Troeger (2006) investigate the impact of political events in key conflict areas, the Gulf War, Israel-Palestine, and Ex-Yugoslavia, on the global stock markets, the Dow Jones, FTSE, and CAC. They use the theory of commercial liberalism to state that financial markets are rational assessors of conflict, and that they only embrace military escalation when it decreases the uncertainty that is likely to be experienced in the long run. The Goldstein scale is used to code political events into co-operative and conflictive, and T-GARCH and E-GARCH models are used to determine the effect of political events on equity returns and conditional volatility. Their results indicate that although markets tend to respond negatively to the increasing conflict, there are cases of war rallies where military intervention is seen to be more likely to solve a crisis faster than otherwise. Conflictive events are discovered to exert a much greater and more regular impact on volatility compared to cooperative events, since negative shocks are more difficult to predict among investors. The geographical proximity also becomes a determinant of heterogeneity, and exchanges that are more proximate to conflict areas have a lesser tendency to respond positively to military escalation.

Hoffmann et al. (2025) discuss the causes of abnormal stock market returns in wartime, the financial effects of 17 military invasions between 2001 and 2022 in G7 and E7 equity markets. They estimate abnormal returns (AR) and cumulative abnormal returns (CAR) using daily closing prices and an event study design with the MSCI World Index as a benchmark across eight different event windows, where the estimation period is 250 days and a 45-day pre-event gap is used to ensure that pre-invasion volatility does not bias the expected return estimates. They find that military invasions tend to have a large negative impact on stock markets, and the strongest responses are on the day of the invasion itself. The findings of heterogeneity show that emerging markets (E7) are much more susceptible to invasion shocks than advanced markets (G7), especially in international conflicts among more than two states. The macroeconomic indicators like stock market maturity, inflation and geographical proximity are identified to explain market reaction more strongly in G7 countries compared to E7 countries.

Overall, the literature shows that wars are likely to affect stock markets negatively because of the uncertainty and disruption of the economy. The size of the effect however differs between countries, sectors and asset classes. The response of the market to conflict is influenced by such factors as geo-graphical proximity, investor sentiment and macroeconomic conditions. Although these studies are very compelling in the evidence presented on the general market reactions, they also indicate that various industries might react in different ways to events related to war. The following part is hence concerned with the defense sector which is likely to show a different reaction when there is a geopolitical war.

2.3 Defense Industry and Stock Performance

Kim and Choi (2014) discuss the impact of portfolio composition in technological alliance networks on the corporate performance of 44 major Korean defense companies in the period between 1995 and 2010. They examine the impact of disparities in innovativeness, reputation and bargaining power among a focal firm and its partners on financial results using a two-step generalized method of moments (GMM) estimator and copatenting as a proxy of technological alliances. They have a sample of seven categories of defense industry, such as maneuver, firepower, battleship, and communication electronics, and target particularly vertical downstream alliances, in which defense companies are partnering with other industry partners. The authors use a five-year decay weighting scheme to explain the declining weight of alliance partners over time, with the last year of collaboration being weighted the most. They find that corporate performance is maximized when the focal firm has a higher bargaining power and reputation than its partners, whereas relatively low innovativeness relative to partners can also pay off by allowing the firm to adopt and imitate the ideas of more innovative partners.

Zhang et al. (2020) explore the existence of asset price bubbles in the Chinese defense industry, discussing whether explosive price dynamics are caused by industry-specific changes or by the general trend in the market. They use sequential unit root tests, namely the SADF and GSADF models, to date-stamp periods of explosive price behavior using monthly closing prices of the CSI National Defence Industry Index and the CSI 300 since January 2005. Their approach recognizes four separate bubble episodes in the defense industry, with the two in 2006 and 2014 being the only ones that were driven by defense-specific factors, i.e., the sudden increases in military spending and the publication of significant defense reform agendas, as opposed to an overall market bubble. The rest of the episodes in 2007 and 2015 are explained by more general trends in the stock market. These results indicate that the defense sector is vulnerable to industry-related revaluations in times of increased strategic investment or policy changes regardless of the general market conditions.

Apergis et al. (2018) test the hypothesis that the GPR index has the ability to forecast the stock returns and volatility of 24 major defense companies worldwide based on monthly data between January 1985 and June 2016. The sample is selected among the leading defense contractors in the US, UK, Germany, and Israel - Lockheed Martin, BAE Systems, and Rheinmetall - based on market leadership, strategic role, and data accessibility. They use a k-th order nonparametric causality test to identify nonlinear relationships in financial time series that are often missed by the traditional linear models. Their results indicate that there is no statistically significant evidence that geo-political risk is a predictor of defense stock returns in a continuous time series. Nevertheless, GPR has been identified to be a strong predictor of realized volatility in half of the sampled firms and the authors conclude that long-term geopolitical tensions tend to change the risk profile of defense firms more than to produce consistent abnormal returns, and the effect of returns seems to be event specific.

Apergis and Apergis (2016) study the stock market response of major international defense companies to the November 2015 terrorist attacks in Paris, driven by the expected cash flow hypothesis, which states that major security failures lead to higher market expectations of a higher military demand and government defense expenditure. They estimate cumulative abnormal returns (CAR) of a sample of large global defense firms on the days following the attacks, based on an event study methodology, where an estimation period is set before the event to isolate abnormal returns due to the shock. They find that there is a statistically significant positive trend in CARs in the sampled firms during the post-event period, which is in line with a flight-to-arms effect, whereby investors use defense stocks as positive valuation opportunities following abrupt security increases.

Callado-Muñoz et al. (2022) investigate the impact of legal changes in defense procurement on the performance of 277 Spanish defense contractors in 2000-2018. They compare main contractors with a control group of other industry participants using a difference-in-differences methodology to isolate the effect of two important regulatory changes implemented in 2011 and 2014. Their results indicate that the two reforms had a strong positive effect on the labor productivity of main contractors, but no statistically significant effect on the profitability of firms. The heterogeneity analysis indicates that the 2011 contract law favored large companies more, whereas the 2014 centralization reform had a greater impact on the productivity of small and medium enterprises.

Apergis and Chatziantoniou (2022) study the impact of US partisan conflict shocks on international stock market returns, stating that domestic political friction is a unique and understudied source of macroeconomic uncertainty. They use a news-based partisan conflict index to determine that partisan conflict shocks have a statistically significant impact on global equity returns, which has explanatory power that is separate to other traditional risk measures like economic policy uncertainty. Their findings indicate that when there is increased political disagreement, investors expect possible policy changes and legislative uncertainty, which also affect international portfolio allocation decisions.

Song et al. (2025) investigate the hypothesis that defense stocks are safe-haven assets by analyzing the impact of geopolitical risk on the US defense sector with monthly data between January 2014 and January 2025, specifically selected to capture the 2014 annexation of Crimea and the entire full-scale invasion of Ukraine in 2022. They use a wavelet-based quantile-on-quantile regression (QQR) framework to break down the correlation between geopolitical risk and defense stock returns over short, medium, and long-term horizons and in bear and bull market regimes, providing a more detailed perspective than the traditional average-based models. They find that in the short run, geopolitical risk has a largely positive impact on defense stocks, which supports the idea that investors consider these assets as safe havens in the case of abrupt geopolitical shocks. The long-term effect is also positive, as it is a reflection of long-term government expenditure and reallocations of the defense budget after significant conflicts. Nevertheless, the medium-term outcomes are heterogeneous, with long-term uncertainty potentially causing market panic and short-term selloffs even in the defense industry.

Bouri et al. (2024) measure return and volatility spillovers between 21 major aerospace and defense companies in six countries on three continents based on weekly data between August 2010 and July 2022, a timeframe that includes several major shocks such as the 2014 annexation of Crimea, the COVID-19 pandemic, and the 2022 invasion Using a quantile vector autoregression (QVAR) model with a 200-day rolling window and a 10-day forecast horizon, they study the dynamics of cross-market linkages in normal, bearish, and bullish market regimes. They find that the spillovers of returns and volatility are stronger during the COVID-19 pandemic and the war in Russia and Ukraine, and connectedness in extreme market regimes is significantly higher than that in normal times. The results of heterogeneity indicate that Chinese defense stocks are mostly disconnected to global markets in the normal condition but are systemically connected during the extreme volatility periods. Geopolitical risk is cited as a key and persistent source of these spillovers and tends to have a more powerful impact on cross-market relationships than more conventional macroeconomic factors.

Adnan et al. (2026) investigate how the Russia-Ukraine war has affected the stock per-performance of 370 defense and aerospace companies in 17 countries. They identify February 24, 2022, as the event date and use an event window of seven days of [-3, +3] with an estimation period of 250 days (t-260 to t-10) to compute abnormal returns using an event study methodology with the OLS market model. Their sample is built using the Thomson Reuters Business Classification system and is limited to publicly traded companies whose main business is in the defense and aerospace industry, and OTC and cross-listed stocks are excluded to maintain data integrity. Their results record a considerably high positive abnormal returns in the sector with an average abnormal return of 1.45% on the event day and cumulative abnormal returns of 5.74% throughout the entire window. The findings of heterogeneity indicate that companies in NATO member countries and large-cap firms had more sustained positive reactions compared to non-NATO and small-cap companies, and companies in countries with strong economic relations to Russia had more return fluctuations, which is an indication of increased investor concern about trade disruptions and sanctions.

Martins et al. (2025) investigate how the stock market of the 100 largest listed defense companies in the world reacted in the short term to the invasion of Ukraine on February 24, 2022. Based on the expected cash flow hypothesis, they utilize an event study approach with both the market model and the Carhart four-factor model to estimate the cumulative abnormal returns in three event windows of [-1, +1], [-1, +5], and [-1, +10] with an estimation period of 120 days between t-140 and t-21 to obtain bench-mark returns over a time frame of relative They find that they have statistically significant positive stock price response throughout the sector with average abnormal returns of 3.24-5.65% in the immediate three-day window. But, for their sub sample analysis of 20 European defense firms, the portfolio CAR ranged from 2.38% to 10.54% across the event windows. The results of heterogeneity indicate that, positive returns are concentrated in firms whose proportion of defense-specific revenues is higher and in those that are located in Europe and the Americas, whereas Asian defense portfolios yielded statistically insignificant results. The size of firms, profitability, and intensity of research and development are found to be important positive contributors to performance in the conflict.

In general, the literature indicates that the defense industry is not as receptive to the overall market during the times of geopolitical tension. Although the majority of industries suffer due to the heightened uncertainty, defense companies tend to gain due to the ex-post expectations of the rise in government expenditure and growth in military products. The extent and orientation of these impacts however varies based on the size of the firm, the geographical location, the regulatory environment, and the severity of geopolitical events. These results indicate the significance of sector-specific analysis in analysing the financial effects of geopolitical conflicts.

2.4 Russia-Ukraine War and Financial Markets

Ahmed et al. (2023) examine how the European stock market responded to the escalation of the Russia-Ukraine crisis on 21 February 2022. They use a sample of companies from the STOXX Europe 600 index. They apply an event study method with a Market Model and an estimation window of 250 days to estimate Average Abnormal Returns (AAR) and Cumulative Abnormal Returns (CAR) in various event windows, from short to longer ones, including [−1, +1], [−3, +3], [−5, +5], [−10, +10], [−15, +15], and [−25, +25]. Their findings reveal a statistically significant negative stock price reaction on the European market as a whole. The largest single day decrease in the primary event windows was found on the event date, where the AAR was -0.41%. At the sector level, seven of the eleven sectors had negative returns. The consumer staples sector hit hardest on the event date (AAR of -0.90%) and the financial services sector was hit hardest over the entire event windows. On the other hand, the energy sector reported positive, though statistically insignificant AAR on the event date and finally recorded positive abnormal returns in the longer post event period, given that companies in this sector benefited from the increase in oil and gas prices after the invasion.

Tee et al. (2023) consider how the economic and financial sanctions against Russia that occurred after the invasion of Ukraine affected the stock markets around the world. In particular, they employ firm-level data of 30,314 firms in 39 countries. Their paper uses a model that is an event study approach with a market model to compute cumulative abnormal returns, and cross-sectional regression analysis to determine moderating variables. Their work results indicate that the stock valuation of firms in countries that enforced sanctions was greater than that of firms in non-sanctioning countries. Moreover, politically related companies and companies in lower geopolitical risk countries were more responsive in the positive reaction. Moreover, the results indicate that investors had higher expectations of political and economic stability in sanctioning nations. They find that the institutional strength and geopolitical positioning affect the stock market responses during periods of conflict.

Umar et al. (2022) discuss the effects of the Russia-Ukraine war on clean energy, conventional energy, and metal markets. Specifically, they use daily data for energy and commodity indices over the period from September 2021 to March 2022. Their model is a simple least squares market model to estimate cumulative aggregate abnormal returns within a specified event window. Their results indicate that there is a substantial increase in abnormal returns in the renewable energy sector on the event day. In addition, conventional energy and metal markets did not show strong reactions at the time of the event. Additionally, the European clean energy markets responded sooner, which implies anticipatory investor action. Their results show that investors changed their preferences to renewable energy as they were worried about disruption of energy supply by Russia.

Chowdhury and Khan (2023) discuss how the war between Russia and Ukraine has affected stock markets in various parts of the world. In particular, they employ daily stock index data of twelve markets during the initial four months of the war. Their paper has a model that is an event study approach with an EGARCH (1,1) model to model volatility dynamics. Their work has mixed reactions in different markets with some countries having positive returns at the beginning and negative cumulative abnormal returns. Besides, the research indicates that there is high volatility clustering in all markets. In addition, those countries, whose trade relied more on Russia and Ukraine, were affected more negatively. Their results indicate that economic exposure and volatility dynamics play an important role in shaping market reactions to geopolitical shocks.

Kiesel and Kolaric (2023) discuss the stock price responses of companies that operate in Russia according to their choice to exit or stay in the market. In particular, they utilize firm-level data of 1,281 foreign firms and follow the corporate decision-making throughout the conflict period. Their paper is based on a typical market model event study to estimate the abnormal returns around the invasion date and the firm announcement date. Their work results indicate that the positive abnormal returns were observed in firms that announced their withdrawal of Russia. Conversely, companies that opted to stay did not experience major stock market responses. In addition, companies that had incurred greater initial losses reacted faster with strategic moves. Their results indicate that investors reward firms that reduce geopolitical and reputation-al risks.

Hofmann and Kanyam (2025) analyze the investor response to corporate actions re-concerning Russian market exposure in large U.S. companies. In particular, they consider data of 221 S&P 500 companies and examine various strategic responses. Their paper has a model of an event study approach with one-way ANOVA to compare the performance of stocks in categories. The findings of their research indicate that companies that suspended their operations had adverse stock price responses as opposed to companies that minimized their exposure. Moreover, consumer-related sectors were not doing as well as other sectors like energy and healthcare. Furthermore, companies that had more operations in Russia were more responsive. Their findings show that the reaction of investors is contingent on the attributes of the firm and the nature of the strategic decision in geopolitical crises.

Das et al. (2023) examine the impact of the Russia–Ukraine war on stock markets in European countries and Russia. They utilize daily firm-level data between November 2021 and May 2022. Their model takes ordinary least squares and fixed effects regressions, as well as the conflict in-tensity measures using online search data. Their work has demonstrated that the effect of their work on the stock returns in the European markets during the war period is significant and negative. Moreover, mining, construction, and manufacturing industries were more severely impacted as they depended on Russian and Ukrainian resources. Furthermore, Russian markets have been the most affected and some of the neutral countries have performed more consistently. Their results indicate that sectoral dependence and geographical exposure are key factors in determining market reactions.

Boungou and Yatié (2022) investigate the impact of the war in Russia and Ukraine on stock market returns in the world in the first months of 2022. The authors use daily stock returns data of 94 countries between January 22 and March 24, 2022, and implement a panel regression model with country and day fixed effects, using Wikipedia Trends as a proxy of the intensity of war. Their results show that there is a negative and statistically significant relationship between the war and stock market returns across the world. The negative market response was most powerful right after the invasion on February 24, 2022, but it became weaker over the next several weeks. Moreover, the effect was more devastating in the nations that were closer to the conflict area and in the United Nations member states that officially denounced the Russian offensive. In general, the analysis reveals that the war created a significant financial disturbance in the global equity markets and the significance of controlling the geopolitical risk.

Martins and Cró (2024) investigate the short-term stock market impact of the Russia–Ukraine war on 74 publicly listed airline companies. Using February 24, 2022, as the date of the event, they use an event study design that is complemented with cross-sectional analysis to evaluate market responses. They find that their findings are negative and statistically significant stock price reaction around the time the conflict broke out. This was especially pronounced on the European airlines, which means that there was a market penalty due to proximity. The authors also discover that bigger, better capitalized and more profitable airlines were more resilient in absorbing the losses incurred during the war. The research finds that the conflict decreased the airline firm value primarily due to the increased operating costs and the uncertainty related to travels.

Martins et al. (2023) study the immediate effect of the war between Russia and Ukraine on European banking stocks. They consider daily stock price data of the 100 largest European banks and examine the date of the event of February 24, 2022. The model they utilize in their paper is an event study approach using both the market model and the Fama–French three-factor model. Their study findings indicate a negative and statistically significant stock price response of European banks after the invasion. Moreover, the banks that were more exposed to Russia were more adversely affected by financial sanctions and reputational risks. Additionally, firm-specific factors like size and profitability mitigated the adverse effect. Their findings suggest that exposure to the conflict and the resilience of firms affect the performance of the stock market in geopolitical events.

3 Theoretical Framework

This chapter will be helpful in establishing a theory for the current research, by introducing some of the core finance theories and analysis frameworks used in the study. It begins with the Efficient Market Hypothesis as the foundation of the financial markets' reaction to new information, followed by the Modern Portfolio Theory (MPT), Asset Pricing Theory (APT) and Behavioral Finance and Prospect Theory. It concludes with the event study methodology which is the empirical approach adopted in this thesis.

3.1 Efficient Market Hypothesis (EMH)

The Efficient Market Hypothesis relates to the speed and accuracy with which information is reflected in financial markets. Building on the work of Bachelier (1900), Fama (1970) introduced the concept by suggesting that, under certain circumstances, price changes incorporate information as it emerges.

Fama describes different levels of efficiency. On one hand, historical price information is already incorporated into current prices; on the other hand, even insider information is reflected. In between is the semi-strong form, which assumes that all public information is quickly impounded.

This form is especially pertinent when considering geopolitical events. The Ukraine invasion was both foreseen and immediately reported and is thus an example of publicly available information. In a semi-strong efficient market, this event should result in a quick adjustment in prices.

This notion is the basis of the empirical approach taken in this thesis. Analysing abnormal returns around the event date provides a way to gauge the market's assessment of the invasion's impact on future returns and risk. The hypothesis of a quick response is consistent with previous research. Caldara and Iacoviello (2022) associate geopolitical uncertainty with reduced economic activity and asset prices, and Khraiche et al. (2023) demonstrate that high geopolitical risk can slow down market growth. Hoffmann et al. (2025) also show that invasions lead to immediate and large market effects.

However, these impacts are not symmetrical. The industry-level effects indicate that while markets overall may fall, some industries profit. In this case, positive abnormal returns for defense companies would suggest that investors immediately adjusted their expectations upwards.

3.2 Modern Portfolio Theory (MPT)

Markowitz (1952) revolutionised investment by refocusing attention from individual assets to the portfolio. Under this theory, an asset does not have a value in and of itself; rather, its value is determined by the way it interacts with other assets to influence portfolio performance.

One consequence is that the risk of the portfolio is determined not only by the risks of the assets in the portfolio, but also by the relationships between them. The presence of imperfect correlations among assets can help reduce return variability. This is the basis for the notion of risk management through diversification. The risk-return trade-off is often illustrated by the efficient frontier, which shows the best risk-return combinations that investors can achieve.

This insight was elaborated upon. Tobin (1958) added the risk-free asset to the mix and Sharpe (1964) built on this work to derive equilibrium pricing formulas. These are key building blocks of traditional finance. When considering geopolitical risk events, the insights of MPT suggest investors are likely to rebalance portfolios as risks and opportunities change. In particular, war can have a differential impact on industries. Some industries may be adversely affected by operational or economic conditions while others (such as defense) may enjoy stronger demand. This is likely to lead to portfolio rebalancing.

This view is supported by recent research. Kotsompolis et al. (2025) show that geopolitical tension can lead to pockets of positive returns for some sectors, even in a negative environment. Song et al. (2025) notes the use of defense-related assets as short-term strategic investments in times of uncertainty, while Banerjee et al. (2024) notes that geopolitical risk is a channel for risk transmission and reallocation.

In this research, MPT offers an explanation for why investors may have rushed into European defense companies after the Ukraine invasion, reflecting a re-evaluation of the prospects for the sector.

3.3 Asset Pricing Theory

Asset pricing models explain the expected returns for assets in terms of risk. Fundamentally, the value of an asset is related to future cash flows and the discount rate used to value those flows.

Early models like the CAPM (Sharpe, 1964; Lintner, 1965; Mossin, 1966) focus on systematic risk, suggesting that only non-diversifiable risk should be priced. But empirical evidence has revealed that this one-factor model is not sufficient. Fama and French (1992, 1993) and Carhart (1997) show that other factors (such as firm size, valuation ratios and momentum) are also important in explaining returns. Ross (1976) provides a more general approach with the Arbitrage Pricing Theory, which permits returns to be affected by multiple sources of systematic risk.

Geopolitical events impact asset prices in two ways. First, expectations of future cash flows can change. For example, for military contractors, more government spending and procurement can lead to higher cash flows. Second, risk may be perceived differently, affecting discount rates. Increased risk can result in investors.

The overall impact depends on the relative strength of the effects. Evidence indicates that for defense companies, the cash flow effect may be substantial. Apergis and Apergis (2016) find positive market reactions to major security events, while Martins et al. (2025) and Adnan et al. (2026) find positive abnormal returns around the Ukraine invasion.

However, the relationship is not consistent over time. Apergis et al. (2018) suggest that geopolitical risk is more related to volatility than to long-term increases in returns. This supports the use of a short-term market response (event-based) approach. In this context, positive stock price reactions in the defense industry can be seen as a result of increases in the expected cash flows outweighing increases in the required return.

3.4 Behavioral Finance and Prospect Theory

The classical financial theory assumes that investors rationally process information. Behavioral Finance departs from this assumption by drawing on psychology, and stresses that people make decisions in a constrained and biased manner. Simon (1955) notion of bounded rationality describes how people are constrained in making optimal decisions.

Prospect Theory (Kahneman and Tversky, 1979) also breaks from the traditional approach by demonstrating that people assess outcomes relative to a reference point. A key implication is that losses are weighed more heavily than equivalent gains. Moreover, people do not evaluate probability in an objective manner, which may affect risk assessment.

Market participants' decisions can also be affected by heuristic-based reasoning (such as availability or representativeness; Tversky and Kahneman, 1974). Such mental shortcuts can be associated with market anomalies like overreactions to news or lagged price responses (De Bondt and Thaler, 1985; Jegadeesh and Titman, 1993). Such effects are exacerbated by geopolitical crises. War events are salient, emotive and may involve significant media attention. Consequently, investor reactions may be driven by both fundamentals and sentiment and attention.

This view is supported by the evidence. Ahmed and Sleem (2025) demonstrate that increased media attention during war can lead to higher volatility and lower returns. Pandey et al. (2024) show the importance of social factors in determining market resilience, and Schneider and Troeger (2006) show that market responses are partly based on how events affect uncertainty. In this paper, there are further insights from behavioural factors. The response to the invasion may be a mixture of rational revaluations and psychological effects.

3.5 Event Study Methodology

This thesis uses an event study to assess the market effects of the invasion. This method compares the observed returns with expected returns over a specified time window around an event.

This approach is based on pioneering empirical studies by Ball and Brown (1968) and Fama et al. (1969) and refined by Brown and Warner (1985) and MacKinlay (1997). These works define the key measures of abnormal returns and how to pool results across companies and time.

An event study generally includes three elements: an estimation period before the event to model normal returns, a brief event window to capture immediate responses and, if applicable, a period after the event to gauge persistence. This design is well adapted to discreet and visible events such as wars.

Prior studies show the value of this framework in studying geopolitical events. Ijaz et al. (2025) report substantial market effects across various asset classes for the Palestine-Israel conflict, while Hoffmann et al. (2025) find that invasions generally have a negative effect. Analyses of sector-specific effects are more mixed, with negative effects on banking and aviation (Martins et al., 2023; Martins and Cró, 2024) and positive effects on defense (Adnan et al., 2026; Martins et al., 2025).

In this thesis, the event date is 24 February 2022, the start of the war in Ukraine. Using both the market model and a multifactor approach, the study seeks to identify abnormal returns, controlling for market returns and other risk factors.

4 Data and Methodology

This chapter describes the data, variables, and empirical methods that were employed to study the effects of the war in Russia and Ukraine on the European defense companies. This research uses an event study approach to examine stock market responses on the date of the event. Both the Market Model and the Carhart Four-Factor Model are used to estimate abnormal returns and ensure robustness of the results.

4.1 Data Collection and Sample Selection

Following prior studies, the starting point for sample construction is the Stockholm International Peace Research Institute (SIPRI) Arms Industry Database SIPRI is a research institute in Stockholm that is an independent research institute and provides systematic and internationally recognized information on the arms-producing and military services companies.

The SIPRI database records annual revenues of arms of publicly listed and privately owned companies and does not include production or maintenance units that are directly run by national armed forces (SIPRI, 2025). The financial information is gathered based on publicly available information, such as annual reports of the companies, regulatory filings, and reliable news sources. The amount of arms revenue is estimated using open-source data and is updated every year with new data being released. This renders the SIPRI database a clear and well utilized reference on the global arms business. The current study is based on the SIPRI list of the Top 100 arms-producing and military services companies of the year 2021, which was accessed on 1 December 2025(SIPRI, 2025).

To construct the European defense sample, the SIPRI dataset was filtered to identify firms headquartered in Europe and classified as arms-producing or military services companies. This process led to a starting sample of 29 companies. Out of this list, 16 firms were selected to be empirically analyzed.

Table 1. European defense firms and their arms revenues in 2021 (based on SIPRI, 2022).

No.	Company	Country	Arms revenues (2021)	Total revenues (2021)	Arms revenues as a % of total revenues (%)
1	BAE Systems	United Kingdom	27080	28300	96
2	Leonardo	Italy	13870	16720	83
3	Airbus	Trans-European	10850	61670	18
4	Thales	France	9770	19150	51
5	Dassault Aviation Group	France	6250	8550	73
6	Rolls-Royce	United Kingdom	5650	15060	38
7	Safran	France	5050	18040	28
8	Rheinmetall	Germany	4450	6690	67
9	Saab	Sweden	4090	4570	89
10	Babcock International Group	United Kingdom	3100	5640	55
11	Fincantieri	Italy	2870	7880	36
12	Serco Group	United Kingdom	1870	6410	29
13	Hensoldt	Germany	1610	1740	93
14	QinetiQ	United Kingdom	1510	1820	83
15	Melrose Industries	United Kingdom	1190	10310	12
16	Kongsberg Gruppen	Norway	1170	3190	37

Table 1 presents the largest European defense companies and their revenue composition in 2021. The statistics indicate that a number of companies, including BAE Systems and Hensoldt, make a large share of their incomes on the military-associated operations, which means that they are highly reliant on military contracts.

A number of firms were filtered out according to certain criteria. Rostec, MBDA, Naval Group, United Shipbuilding Corporation, Tactical Missile Corporation, PGZ, UkrOboronProm, Navantia and Diehl were not included due to not being publicly listed or being government owned or privately owned companies. Cobham and Meggitt were not included because they were acquired in the sample period. ThyssenKrupp was not included since its arms revenue represented less than 6% of total revenue, which is in line with the selection criteria employed in previous studies (Martins et al., 2023).

The University of Vaasa terminal was used to access the Refinitiv Eikon database to get daily stock market data of the final sample of 16 firms. The data of daily closing prices and market capitalization of each firm was gathered between 5 February 2021 and 10 March 2022. Based on this data, daily stock returns were calculated and the variables needed to conduct the empirical analysis were constructed.

4.2 Description of Variables

This paper uses both the return-based variables and factor variables to examine the stock market response of the European defense companies to the Russia-Ukraine war. The variables are all built on daily data and are in the form of decimals to ensure that models are consistent.

4.2.1 Stock Returns

Daily stock returns for each firm are calculated using closing prices obtained from the Refinitiv Eikon database. In this study, logarithmic returns are used due to their desirable statistical properties, including time additivity and improved normality. Campbell et al. (1997) (Adnan et al., 2026)

Logarithmic returns are calculated as:

$$R_{it} = \ln\left(P_{it}/P_{it-1}\right), \tag{1}$$

where R_{it} denotes the return of firm i on day t, and P_{it} and P_{it-1} represent the closing prices at time t and $t-1$, respectively.

4.2.2 Portfolio Return

Besides the analysis at the firm level, an equally weighted portfolio is created to reflect the sector-level performance. The portfolio return is the average of the firm returns. MacKinlay (1997)

The return of portfolio is examined using the equation

$$R_{pt} = \frac{1}{N}\sum_{i=1}^{N} R_{it} \ , \qquad (2)$$

where N represents the number of firms in the sample. This approach ensures that each firm contributes equally to the portfolio and avoids bias toward larger firms.

4.2.3 Market Return

The market return is a general market performance which is approximated by benchmark stock market indices. In the firm-level analysis, country-specific total return indices based on the location of listing of each firm are employed to make sure that the expected returns are based on domestic market conditions. A similar approach has been adopted in earlier studies examining defense returns and market reactions (Martins et al., 2024; Adnan et al., 2026).

The indices used are the FTSE All-Share Total Return Index for the United Kingdom, the CAC 40 Total Return Index for France, the DAX Total Return Index for Germany, the FTSE MIB Total Return Index for Italy, the Sweden All Share Total Return Index for Sweden, and the Oslo OBX Total Return Index for Norway. These indices include dividend reinvestments and hence give a holistic view of overall market performance.

In the analysis of the portfolio level, there is a need to have a common benchmark to reflect broader movements in the market amongst firms. Thus, the market proxy is the STOXX Europe 600 Index, which is a wide representation of the European equity market. All market index data are obtained from the Refinitiv Eikon database from University of Vaasa terminal.

4.2.4 Risk-Free Rate

The risk-free rate (R_{ft}) represents the return on a risk-free asset and is obtained from the Kenneth French Data Library. It is used to compute excess returns in the four-factor model.

4.2.5 Factor Variables

The Carhart Four-Factor Model is used to control other sources of systematic risk. The data in the factor are taken out of the Kenneth French Data Library and contain the following variables:

- Market Excess Return (Mkt-RF): The difference between the market return and the risk-free rate.
- SMB (Small Minus Big): The size effect is captured by the difference between the returns of small-cap and large-cap firms.
- HML (High Minus Low): The value effect is captured by the difference between the returns of high and low book-to-market firms.
- MOM (Momentum): Measures the momentum effect, which quantifies how past winning stocks are likely to performing well.

All the factor values are initially in percentage form and are converted into decimal form before analysis.

4.2.6 Excess Returns

For the Carhart Four-Factor Model, excess returns are calculated as:

$$R_{it} - R_{ft} \,, \tag{3}$$

for firm-level analysis, and:

$$R_{pt} - R_{ft} \,, \tag{4}$$

for portfolio-level analysis. These excess returns serve as dependent variables in the four-factor regression model.

4.3 Event Definition and Event Windows

The event examined in this study is the outbreak of the Russia–Ukraine war between Russia and Ukraine, which was characterized by the full-scale invasion of Ukraine by Russia on 24 February 2022. This event represents a significant geopolitical shock that has direct consequences on the expectations of investors, their perception of risk, and the valuation of the sector, especially the defense industry.

In order to analyze the stock market response, this paper uses an event study methodology. Event studies are widely used in finance to assess how quickly and efficiently new information is incorporated into stock prices (MacKinlay, 1997). The day 0 is the event date in this study and the main event window is -10, +10 trading days. This symmetric window is selected to not only record the immediate market reaction to the invasion, but also potential information leakage prior to the event and slow adaptation following the event. This would be suitable in geopolitical shock context where uncertainty can accumulate over time before the formal shock date and where re-evaluation of investors can persist in the days after the shock.

The choice of the event window is also supported by previous literature on war and geopolitical conflict. Previous event-study literature has revealed that military conflicts tend to cause intense stock market responses that are highly concentrated around the date of the event but can persist into a few days of trading. To illustrate, Ijaz et al. (2025) consider the event window of [-5, +5] to examine the short-term effect of the Palestine-Israel war on the global asset markets, and Pandey et al. (2024) use the event window of [-7, +7] to analyze the global stock market response to the Israel-Hamas conflict. Hoffmann et al. (2025), in their study of military invasions, use various event windows to measure both short-term and long-term market reactions. In a study directly connected to the Russia-Ukraine war, Adnan et al. (2026) consider the abnormal returns of defense and aerospace companies with a [-3, +3] event window, but Martins et al. (2025) consider the short-term performance of listed defense companies with a [-1, +1], [-1, +5], and [-1, +10] window. This research demonstrates that short and medium symmetric windows are prevalent in literature and are especially appropriate in capturing the timing and persistence of abnormal returns related to war.

Based on this literature, the [-10, +10] window is suitable as it is wide enough to give a larger view of market adjustment compared to shorter windows alone but narrow enough to contain contamination caused by events not related to the market. As geopolitical shocks can produce both short-term response and further re-evaluation, a broader event window will assist in determining whether the abnormal returns are focused on the event day or extend to the following trading days.

Besides the main event window, a number of sub-event windows are also analyzed to give a more detailed analysis of timing and duration of abnormal returns. These include [0,0], [-1, 0], [0, +1], [-1, +1], [-3, +3], [-5, +5], and [-10, +10]. The application of multiple windows is in line with the suggestions of MacKinlay (1997) and Kothari and Warner (2007) who observe that the analysis of alternative event windows enhances the strength of the event-study results and enables the researcher to differentiate between short-term, immediate and somewhat broader market reactions. It is also based on the tradition of earlier studies on war-related matters, which generally are based on multiple event windows instead of a single specification (Ahmed et al., 2023).

4.4 Estimation Window

The estimation window is used for the process of generating returns of the sample firms before the event. In event study, the estimation window should be long enough to give reliable estimates of the parameters and at the same time it should be free of contamination due to the event of interest (MacKinlay, 1997). This makes sure that the expected returns are normal market movements and not abnormal movements caused by the event.

In this paper, the estimation window is 252 trading days before the event window, which is from 8 February 2021 to 25 January 2022. The fact that about one trading year of daily data is used is also in line with the accepted event study practice, where it gives a large enough number of observations to estimate constant parameters to expected return models (MacKinlay, 1997; Kothari and Warner, 2007). The longer estimation window enhances statistical reliability by minimizing the estimation error and the ability to capture normal variations in market conditions.

The selected length is also justified by the empirical literature that studies geopolitical shocks and war-related events. As an illustration, Pandey et al. (2024) use an estimation window of 250 trading days in their study of stock market response to the Israel Hamas conflict, and Hoffmann et al. (2025) adopt a 250-day estimation period in their study of stock market reactions to various military invasions. Similarly, Adnan et al. (2026) use a 250-day estimation window in their event study of defense and aerospace companies in the Russia-Ukraine war. These studies show that one year estimation period is very common in literature, especially when it comes to geopolitical events because it is a balance between statistical accuracy and the necessity to eliminate structural breaks in the data.

There exists gap of 11 days between the estimation window and the event window to ensure that there is no possible information leakage or anticipation effects that may affect the estimation of model parameters. This is particularly relevant in geopolitical events where the market participants can eventually build expectations of conflict prior to the actual date of the event. Empirical research on market responses to war events shows that there is a potential to have pre-event information effects, and it is required to separate the estimation period and the event window (Hoffmann et al., 2025; Ijaz et al., 2025). The gap also helps in estimating the parameters in a better way that is more representative of normal market conditions than anticipatory trading behavior.

The same estimation window is applied consistently across all firms and models, including both the Market Model and the Carhart Four-Factor Model. This ensures that the results of different model specifications are comparable and minimizes the possible biases that might come about due to variations in parameter estimation. The consistency in the estimation period is especially crucial when comparing the abnormal returns based on other benchmarks because it guarantees that any disparities in the outcomes are caused by the model choice and not disparities in the underlying data.

4.5 Market Model

The Market Model is employed to estimate the expected returns of individual firms based on their relationship with overall market movements. It is one of the most widely used models in event study methodology due to its simplicity and effectiveness in capturing systematic risk. (Fama et al., 1969)

The Market Model is specified as follows:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \,, \tag{5}$$

where R_{it} represents the return of firm i on day t, R_{mt} denotes the market return, α_i is the intercept term, β_i measures the sensitivity of the firm's return to market movements, and ϵ_{it} is the error term.

The parameters α_i and β_i are estimated using ordinary least squares (OLS) regression over the estimation window. These estimated coefficients are then used to compute expected returns during the event window.

For the firm-level analysis, country-specific market indices are used as proxies for market returns to ensure that expected returns reflect domestic market conditions. For the portfolio-level analysis, the STOXX Europe 600 Index is used as the market benchmark to capture broader European market movements.

The expected return for each firm during the event window is calculated as:

$$E(R_{it}) = \hat{\alpha}_i + \hat{\beta}_i R_{mt} \ , \tag{6}$$

where $\hat{\alpha}_i$and $\hat{\beta}_i$are the estimated parameters obtained from the estimation window.

The Market Model provides a benchmark for normal performance, allowing abnormal returns to be identified as deviations from expected returns during the event window.

4.6 Carhart Four-Factor Model

To provide a more comprehensive estimation of expected returns, this study employs the Carhart Four-Factor Model as an extension of the Market Model. The model incorporates additional risk factors beyond market risk, allowing for a more accurate assessment of abnormal performance (Carhart, 1997).

The Carhart Four-Factor Model is specified as follows:

$$R_{it} - R_{ft} = \alpha_i + \beta_m (R_{mt} - R_{ft}) + s_i SMB_t + h_i HML_t + m_i MOM_t + \epsilon_{it} \ , \tag{7}$$

where R_{it} represents the return of firm i on day t, R_{ft} is the risk-free rate, and $(R_{mt} - R_{ft})$ denotes the market excess return. The variables SMB_t, HML_t, and MOM_trepresent the size, value, and momentum factors, respectively. The coefficients s_i, h_i, and $m_i$measure the sensitivity of firm returns to these factors, while $\alpha_i$represents abnormal performance not explained by systematic risk factors.

The model is estimated using ordinary least squares (OLS) regression over the estimation window. Factor data, including market excess return, SMB, HML, MOM, and the risk-free rate, are obtained from the Kenneth French Data Library. All factor values are converted from percentage to decimal form prior to estimation to ensure consistency with stock returns.

For the portfolio-level analysis, the same model is applied using portfolio excess returns as the dependent variable. This allows for the evaluation of sector-wide abnormal performance while controlling for multiple sources of systematic risk.

The expected return under the four-factor model is calculated as:

$$E(R_{it} - R_{ft}) = \hat{\alpha}_i + \hat{\beta}_m(R_{mt} - R_{ft}) + \hat{s}_i SMB_t + \hat{h}_i HML_t + \hat{m}_i MOM_t \ , \qquad (8)$$

The Carhart Four-Factor Model serves as a robustness check for the Market Model by accounting for additional risk factors that may influence stock returns. This helps to ensure that the estimated abnormal returns are not driven by common systematic risk exposures.

4.7 Abnormal Returns and CAAR calculation

The primary objective of the event study is to measure the impact of the event on stock returns through abnormal returns. Abnormal returns represent the difference between actual returns and expected returns estimated from the chosen model.

4.7.1 Abnormal Returns

Under the Market Model, abnormal returns are calculated as:

$$AR_{it} = R_{it} - (\hat{\alpha}_i + \hat{\beta}_i R_{mt}) \ , \qquad (9)$$

where $AR_{it}$is the abnormal return of firm $i$on day t, $R_{it}$is the actual return, and $\hat{\alpha}_i$and $\hat{\beta}_i$are the estimated parameters obtained from the estimation window.

Under the Carhart Four-Factor Model, abnormal returns are computed using excess returns:

$$AR_{it} = (R_{it} - R_{ft}) - \left(\widehat{R_{it} - R_{ft}}\right) , \qquad (10)$$

where $(\widehat{R_{it}-R_{ft}})$represents the expected excess return estimated from the four-factor model.

4.7.2 Average Abnormal Return (AAR)

To evaluate the overall market reaction across firms, abnormal returns are averaged across all firms for each event day. The Average Abnormal Return (AAR) is defined as:

$$AAR_t = \frac{1}{N}\sum_{i=1}^{N} A\,R_{it}\ , \tag{11}$$

where $N$is the number of firms in the sample.

4.7.3 Cumulative Average Abnormal Return (CAAR)

To capture the total impact of the event over a specified period, cumulative abnormal returns are calculated. The Cumulative Average Abnormal Return (CAAR) is defined as:

$$CAAR_{(T_1,T_2)} = \sum_{t=T_1}^{T_2} AA\,R_t\ , \tag{12}$$

where $T_1$and T_2represent the start and end of the event window, respectively.

4.8 Portfolio Construction

In addition to firm-level analysis, this study employs a portfolio-level approach to examine the aggregate impact of the event on the European defense sector. Portfolio analysis is commonly used in event studies to capture sector-wide effects and to provide a robustness check for firm-level results.

An equally weighted portfolio is constructed using the sample of 16 firms. The portfolio return is calculated as the average of individual firm returns:

$$R_{pt} = \frac{1}{N}\sum_{i=1}^{N} R_{it}\ , \tag{13}$$

where R_{pt} denotes the portfolio return on day t, R_{it} represents the return of firm i, and N is the number of firms in the sample.

The use of an equally weighted portfolio ensures that each firm contributes equally to the overall portfolio performance, thereby avoiding bias toward larger firms with higher market capitalization. This approach is widely adopted in empirical finance studies when the objective is to assess the general behavior of a specific sector.

Portfolio abnormal returns are computed using both the Market Model and the Carhart Four-Factor Model. For the Market Model, expected portfolio returns are estimated based on the relationship between portfolio returns and the market return. For the four-factor model, portfolio excess returns are regressed on the market excess return, size, value, and momentum factors.

The use of portfolio-level analysis complements firm-level results by providing a broader perspective on how the defense sector as a whole responds to the event. This approach also serves as a robustness check to verify whether the observed effects are consistent across different levels of aggregation.

4.9 Statistical Testing

To evaluate the statistical significance of abnormal returns, this study employs both cross-sectional and time-series t-tests, following standard event study methodology.

4.9.1 Firm-Level Testing

At the firm level, the statistical significance of cumulative abnormal returns is assessed using a cross-sectional t-test. This approach examines whether the average cumulative abnormal return across firms differs significantly from zero.

The test statistic is calculated as:

$$t = \frac{CAAR}{SD(CAR_i)/\sqrt{N}}, \quad (14)$$

where $CAAR$ represents the cumulative average abnormal return over a given event window, $SD(CAR_i)$ is the standard deviation of cumulative abnormal returns across firms, and N is the number of firms in the sample.

4.9.2 Portfolio Level Testing

At the portfolio level, statistical significance is evaluated using a time-series t-test based on abnormal returns over the event window. The test examines whether the mean abnormal return differs significantly from zero over time.

The test statistic is computed as:

$$t = \frac{\bar{AR}}{SD(AR_t)/\sqrt{T}}, \quad (15)$$

where $\bar{AR}$ is the average abnormal return over the event window, $SD(AR_t)$ is the standard deviation of abnormal returns across time, and T is the number of observations within the event window.

5 Empirical Results

This chapter presents the empirical results of the study. The findings are presented in the following sections: first descriptive statistics, second AAR at the firm level are discussed. Third, CAAR at the firm level are examined across different event windows. Finally, the portfolio-level CAR are presented to provide an overall picture of the defense sector's response to the event.

5.1 Descriptive Statistics

This section provides the descriptive statistics of the variables used in the study. Table 2 reports the descriptive statistics of the portfolio returns and risk factors during the estimation period. The results show that the average daily portfolio return is 0.05%, which implies a low positive return over the sample period. The standard deviation of 1.12% indicates a medium volatility of portfolio returns. The minimum and maximum values are -5.60% and 3.35%, respectively and suggest that there is a slight negative skewness by capturing the asymmetry in the tails.

Similarly, the market return and the market risk premium (Mkt-Rf) are same in terms of the mean (both 0.05%) and very close in standard deviation i.e., 0.82% and 0.78% respectively, which means that the risk-free rate is small relative to market movements during the estimation period. The market indicates lower volatility than portfolio, which may show that the portfolio carries idiosyncratic or factor-specific risk beyond the market.

The size factor (SMB) has a slightly negative mean (-0.01%), which means that small-cap stocks marginally underperformed large-cap stocks on average during the estimation period. The value factor (HML) has a positive mean of 0.10%, which indicates that the performance of value stocks will outperform on average than that of growth stocks. The mean of the momentum factor (MOM) is 0.04% and a standard deviation of 0.62%. The minimum of -2.25% and maximum of +1.72% indicates the crash risk of momentum strategies.

Table 2. Descriptive Statistics focused on the estimation window.

Variable	Mean	Standard Deviation	Minimum	Maximum
Portfolio Return	0.0005	0.0112	-0.0560	0.0335
Market Return	0.0005	0.0082	-0.0389	0.0242
Mkt-Rf	0.0005	0.0078	-0.0360	0.0245
SMB	-0.0001	0.0045	-0.0127	0.0148
HML	0.0010	0.0083	-0.0269	0.0262
MOM	0.0004	0.0062	-0.0225	0.0172

Notes: This table reports descriptive statistics for daily returns and Fama–French–Carhart factor variables over the estimation window. Portfolio Return represents the average daily return of the sample firms, while Market Return denotes the return on the market index(STOXX600). Mkt–Rf is the excess market return over the risk-free rate, and SMB (Small Minus Big), HML (High Minus Low), and MOM (momentum) are the size, value, and momentum factors, respectively. All values are expressed in daily terms.

5.2 Average Abnormal Returns (AAR)

Table 3 shows the Average Abnormal Returns (AAR) for each day in the event window from day -10 to day +10 where day 0 indicates 24 February 2022, using both the Market Model and the Carhart Four-Factor Model. These returns are also illustrated in Figure 1, where the trend of the market reaction to the event can be seen.

Before the event, the results show mixed evidence of abnormal returns. As can be seen in Figure 1, both lines fluctuate close to zero in the pre-event period. The majority of AAR have statistically insignificant abnormal returns under both models which is consistent with the semi-strong form of market efficiency and suggests the absence of systematic information leakage. But, on day -10, where both models show statistically significant positive AARs at 1% significance level (MM=1.478%, FF4=1.280%), though this is likely due to unrelated market movements rather than event related information. Low negative and significant returns appear on days -5 and -3 under the market model but not consistent with the FF4 model. This suggests that the findings are a result of market uncertainty in the days before the invasion, rather than by investors trading on early information about the event.

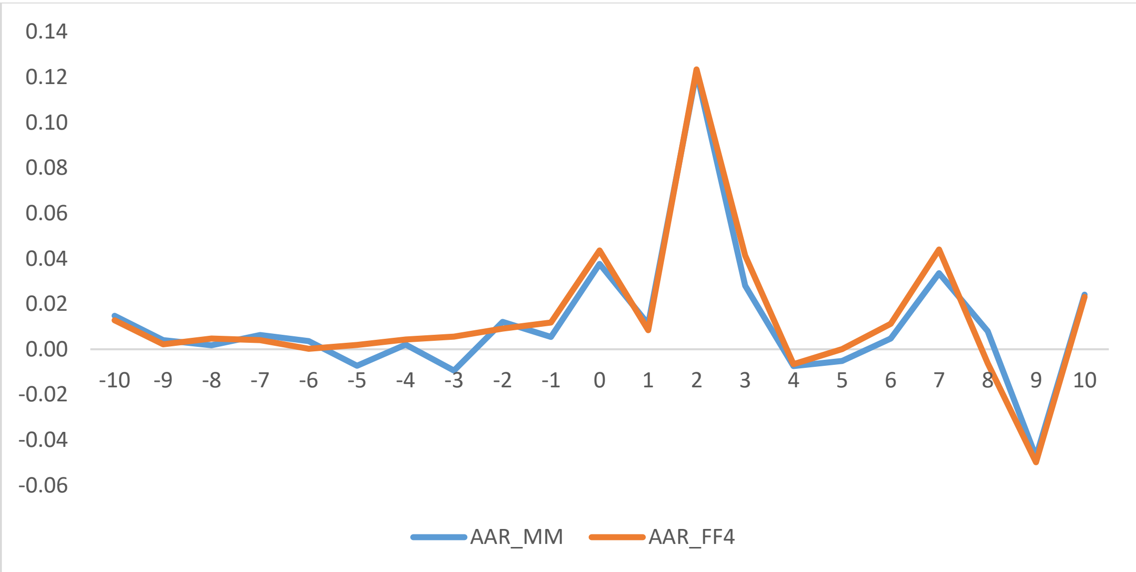
However, on the event date both models show a clear and significant positive abnormal return. The Market Model with an AAR of 3.776% while the FF4 Model with an AAR of 4.358% are both significant at the 5% and 1% level respectively. This means that as soon as the war started, investors reacted quickly and positively to defense stocks. This is probably because investors expected that governments might increase defense spending in response to the war, which would benefit defense companies directly.

The positive reaction continues in the days after the event. As shown in Figure1, both lines rise sharply after day 0. Day +1 still shows positive and significant returns under both models. The most significant result occurs on day +2 with AAR of the Market Model is 12.219% and the FF4 Model is 12.344% and both are significant at 1% level. These are the largest abnormal returns observed across the entire event window. This suggest that the full market reaction did not happen all at once on day 0. Instead, it built up over the following two days, as more investors processed the news and revised their expectations about the future performance of defense companies. By day +3, returns are still positive but begin to decrease, suggesting that the market was starting to absorb the new information.

After day +3, the pattern becomes more mixed. This is evident in Figure 1, where the lines start to fluctuate up and down. On days +4 and +5, the returns are slightly negative, but not significant. On day +7, both models record a significant positive return again, with the Carhart Four-Factor Model showing 4.405%. This could be due to renewed investor interest with the release of more information and announcements after the invasion. However, on day +9, both models show significant negative returns, with the Market Model of −4.745% and the Carhart Four-Factor Model showing −4.983%. This large negative return suggests that the market partially reversed the earlier positive returns, perhaps due to profit taken by investors.

When comparing the two models, the Carhart Four-Factor Model tends to yield slightly higher AAR estimates than the Market Model. This can also be seen in Figure 1, where the orange line is slightly above the blue line around the event date and on day +2. This small difference in magnitude may be due to exchange rate fluctuations during the event period, as the Carhart risk factors were converted from US Dollars to Euros. However, both models show the same direction, timing, and statistical significance of abnormal returns throughout the event window, which confirms that the overall results are robust and consistent across both model specifications.

Figure 1: AAR Plot Around the Event Date



Overall, the AAR results provide clear evidence that the outbreak of the Russia-Ukraine war had a positive impact on European defense stocks. The market reacted immediately on the date of event and continued strong and positive until day +2. While there were some fluctuation and partial correction occurred in the later post-event period, the general pattern remains positive. This result supports the hypothesis that the defense companies have positive abnormal return during the war.

Table 3. Average Abnormal Returns (AAR) and Cross- Sectional t-Statistics Around the Event Date.

Event days	AAR_MM	t-stat (MM)	AAR_FF4	t-stat (FF4)
-10	1.478***	3.626	1.280***	3.878
-9	0.402	1.296	0.222	0.793
-8	0.184	0.361	0.469	1.041
-7	0.623	1.445	0.397	1.236
-6	0.354	1.318	0.027	0.106
-5	-0.726***	-3.529	0.197	0.787
-4	0.204	0.818	0.432*	1.945
-3	-0.934**	-2.394	0.561	1.093
-2	1.211**	2.050	0.918	1.613
-1	0.544	1.155	1.181**	2.522
0	3.776**	2.475	4.358***	3.082
1	1.104*	1.807	0.837**	2.266
2	12.219***	3.890	12.344***	4.022
3	2.809	1.403	4.134**	2.244
4	-0.737	-0.553	-0.655	-0.483
5	-0.520	-0.588	0.011	0.014
6	0.476	0.607	1.130	1.625
7	3.353**	2.380	4.405***	3.359
8	0.795	1.165	-0.617	-0.806
9	-4.745***	-2.981	-4.983***	-3.864
10	2.414**	2.294	2.304**	2.454

Notes: Average abnormal returns (AAR) are calculated across all sample firms around the event date (t = 0), corresponding to 24 February 2022. AAR_MM and AAR_FF4 denote abnormal returns estimated using the Market Model and the Fama–French four-factor model, respectively. Event days range from -10 to +10, where negative (positive) values indicate trading days before (after) the event. All values are expressed in percentage terms. The reported t-statistics are based on cross-sectional standard errors. Statistical significance is denoted by ***, **, and *, corresponding to the 1%, 5%, and 10% levels, respectively.

5.3 Cumulative Average Abnormal Returns (CAAR)

Table 4 presents the Cumulative Average Abnormal Returns (CAAR) for different event windows based on both the Market Model and the Carhart Four-Factor Model.

The results show that CAAR results show a strong and statistically significant positive market reaction even in the shortest event windows. At the event day [0,0], CAAR records 3.766% under the Market Model and 4.010% under the Fama French four-factor model, both significant at the 5% level. This indicates that European defense stocks reacted positively on the day the invasion.

When the window is extended to include one day before and after the event, the CAAR increases further. The [−1, +1] window results in a CAAR of 5.415% (Market Model) and 6.375% (Carhart Four-Factor Model), respectively, both significant. This implies that the market response was not only on the event day, but also the days before and after. The one-sided windows show that the pre-event window [−1, 0] has CAARs of 4.310% and 5.538%, while the post-event window [0, +1] has 4.871% and 5.194% under the two models respectively. The positive and significant CAARs in both windows suggest that the market reaction was not limited to the event date alone but also spread into the surrounding days.

As the event window widens, the CAAR increases substantially. The [−3, +3] window records a CAAR of 20.720% under the Market Model and 24.332% under the Carhart Four-Factor Model, both significant at the 1% level. This substantial increase over the shorter windows is due to the large abnormal returns on day +2, as shown in Table 3, which are now incorporated in this window. This finding confirms that most of the market reactions happened in the first few days following the event.

Table 4. Cumulative Average Abnormal Returns (CAAR) across Event Windows.

Event Windows	CAAR_MM	t-stat (MM)	CAAR_FF4	t-stat (FF4)
[0, 0]	3.766**	2.475	4.010**	2.601
[-1, 0]	4.310**	2.380	5.538***	3.353
[0, +1]	4.871**	2.820	5.194***	3.163
[-1, +1]	5.415**	2.720	6.375***	3.455
[-3, +3]	20.720***	3.107	24.332***	3.880
[-5, +5]	18.940***	3.267	24.317***	4.792
[-10, +10]	24.275***	3.527	28.950***	4.661

Notes: CAAR represents the average cumulative abnormal return across sample firms over the specified event window. CAAR_MM and CAAR_FF4 denote cumulative abnormal returns estimated using the Market Model and the Fama–French four-factor model, respectively. Event windows represent trading days relative to the event date (t = 0), corresponding to 24 February 2022. All values are expressed in percentage terms. The reported t-statistics are based on cross-sectional standard errors. Statistical significance is indicated by ***, **, and *, corresponding to the 1%, 5%, and 10% levels, respectively.

The [−5, +5] window has a CAAR of 18.940% (Market Model) and 24.317% (Carhart Four-Factor Model), both significant at the 1% level. The CAAR under the Market Model is slightly smaller in the [−5, +5] window than in the [−3, +3] window. This is probably because the negative abnormal returns on days −5 and −4 are now included in the wider window, which partly cancels the positive returns around the event day.

The longest event window [−10, +10] results in the highest CAAR in this study, 24.275% under the Market Model and 28.950% under the Carhart Four-Factor Model, both at the 1% significance level. The increase in CAAR as the window gets wider demonstrates that the positive market response did not dissipate immediately after the event. Rather, it had a longer-lasting effect, implying that investors remained positive about European defense stocks for a longer time than just the immediate days after the invasion.

Across all event windows, the CAAR estimates from the Carhart Four-Factor Model are greater than those from the Market Model. This minor difference in magnitude may be explained by the exchange rate fluctuations that occurred during the event period, since the Carhart risk factors were translated from US Dollars to Euros. However, both models show the same sign and significance for all event windows. This suggests that the results are not sensitive to the benchmark model.

Overall, the CAAR results presents consistent evidence that the outbreak of the Russia-Ukraine war generated significant positive cumulative abnormal returns in European defense stocks across all event windows examined. The statistically significant positive CAARs in both short and long windows indicate that the market response was immediate and long-lasting. This evidence is consistent with the view that the market expected a significant boost in future defense spending in response to the invasion, which resulted in a long-term revaluation of European defense stocks.

5.4 Portfolio-Level Analysis

This section presents portfolio-level results to examine the aggregate impact of the event on the European defense sector. An equally weighted portfolio is constructed using the sample firms, and cumulative abnormal returns (CAR) are computed using both the Market Model and the Carhart Four-Factor Model.

Table 5 presents the portfolio-level CAR for different event windows. The results show that abnormal returns are positive across all event windows under both models. At the event day [0,0], the CAR records of 3.776% (Market Model) and 4.358% (FF4). This shows that the portfolio of defense sector firms recorded a positive abnormal return on the day of the invasion, as reported in the AAR in Table 3.

When the window is extended to include the surrounding days, the CAR continues to grow. The [−1, +1] window results in a portfolio CAR of 5.468% under the Market Model (significant at the 10% level) and 6.375% under the Carhart Four-Factor Mod-el (significant at the 10% level). This indicates that the positive response of the defense portfolio was not limited to the event date but also included the days around the invasion. The pre-event window [−1, 0] has a CAR of 4.415% under the Market Model and 5.538% under the Carhart Four-Factor Model, significant at the 10% level. The post-event window [0, +1] records 4.819% under the Market Model, significant at the 10% level, and 5.194% under the Carhart Four-Factor Model but is not significant. This finding suggests that the portfolio started to respond positively prior to the event and continued to respond positively after the event.

When the event window is extended, the portfolio CAR grows significantly. The [−3, +3] window has a CAR of 19.826% (significant at the 10% level) under the Market Model and 24.332% (significant at the 5% level) under the Carhart Four-Factor Model. This substantial increase is mostly due to the very large abnormal returns recorded on day +2 at the portfolio level, as shown in Table 3. This indicates that most of the cumulative abnormal return of the defense portfolio occurred in the first few days following the event.

The [−5, +5] window produces a CAR of 18.449% for the Market Model, and 24.317% for the Carhart Four-Factor Model, with only the FF4 model being significant at the 5% level. The slight decline in the Market Model CAR compared to the [−3, +3] window suggests that some negative abnormal returns at the tails of this longer window cancelled out some of the large positive returns around the event date.

Table 5. Portfolio-Level Cumulative Abnormal Returns (CAR) Across Event Windows.

Event Window	Market Model CAR	t-stat	FF4 CAR	t-stat2
[0,0]	3.776	n/a	4.358	n/a
[-1,0]	4.415	1.417	5.538*	1.743
[0, +1]	4.819*	1.777	5.194	1.475
[-1, +1]	5.468*	1.863	6.375*	1.896
[-3, +3]	19.826*	1.800	24.332**	2.176
[-5, +5]	18.449	1.539	24.317**	1.969
[-10, +10]	24.013*	1.774	28.950**	1.970

Notes: CAR denotes cumulative abnormal returns aggregated over each event window for the portfolio of European defense firms. CAR is computed using the Market Model (MM) and the Fama–French four-factor model (FF4). Event windows are defined relative to the event date (t = 0), corresponding to 24 February 2022. CAR values are reported in percentage. The reported t-statistics are based on cross-sectional standard errors. Statistical significance is denoted by ***, **, and * for the 1%, 5%, and 10% levels, respectively. t-statistics are not reported for single-day windows due to insufficient observations.

The longest event window [−10, +10] results in a portfolio CAR of 24.013% under the Market Model, significant at the 10% level, and 28.950% under the Carhart Four-Factor Model, significant at the 5% level. The fact that the CAR portfolio keeps increasing as the event window expands suggests that the positive abnormal returns for the defense sector did not disappear soon after the event. Rather, they continued for a longer time, implying that investors' positive sentiment towards European defense stocks remained in the longer event window.

The Carhart Four-Factor Model results in higher portfolio CAR estimates across all event windows compared to the Market Model. The Carhart model also produces a greater number of significant results in the medium and long-term windows. As mentioned above, this minor difference may be due to exchange rate fluctuations in the event window (Carhart risk factors were converted from US Dollars to Euros). However, the results for the portfolio CAR are consistent across both models, with positive CAR across all event windows, and thus the results are robust with respect to the benchmark model.

Overall, the portfolio-level CAR results are consistent with the CAAR findings reported in Table 4. The European defense sector portfolio generated substantial positive cumulative abnormal returns in both short and long event windows in response to the Russia-Ukraine war.

6 Discussion

This chapter interprets the empirical findings and places them within the broader context of financial theory and existing literature. It also discusses the implications of the results for investors and policymakers.

6.1 Comparison with Previous Studies

At the broadest level, the results of this study are consistent with the Caldara and Iacoviello (2022), who indicated that an increase in geopolitical risk is typically associated with a rise in market uncertainty and negative economic effects for the economy. While their research is at the macroeconomic level, the abnormal returns observed positive and negative in this study over the period around the invasion show that European defense markets reacted strongly and rapidly to the geopolitical shock. This rapid market response is consistent with the semi-strong form of the Efficient Market Hypothesis, which suggests that stock prices react immediately to new public news.

At the portfolio level, Martins et al. (2025) report a CAR of 2.38% (Market Model) and 2.49% (Carhart Four-Factor Model) respectively in the [−1, +1] window for a sub sample of 20 European defense companies. The present study reports a larger CAR portfolio of 5.468% and 6.375% respectively during the same period. This magnitude implies a greater positive response in the portfolio of European defense firms of the present study compared to that of Martins et al. (2025). One reason for this may be the difference in sample selection and period of data collection and estimation period as the companies in the current sample may be more affected by the expected rise in European defense spending following the invasion. Although the magnitude of the market reaction differs, both studies are consistent on the direction of the reaction, as we also observe a positive portfolio-level CAR across all event windows and model specifications. The consistent in direction between two different studies is a clear indication that European defense stocks responded positively to the outbreak of the Russia-Ukraine war.

At the individual firm level Adnan et al. (2026) report an AAR of 1.45% on the event date and a CAAR of 5.74% in the [−3, +3] window for 370 defense firms from 17 countries. This study reports an AAR of 3.776% on the day of the event and a CAAR of 20.720% in the [−3, +3] window using the Market Model. This is expected as their sample is global. Given that their sample includes aerospace and defense companies from 37 different countries, with many of these countries located far from the conflict, it is natural for their sample to weaken the market response. The current study is solely based on the sample of European defense companies, which are more relevant to the conflict and have closer ties to the anticipated growth in European spending. It is likely that this explains why both the firm-level CAAR and portfolio-level CAR reported in the present study are much larger.

This study's finding of significant positive abnormal returns for European defense stocks is in contrast to the stock price reactions of other European industries during the same period. Martins et al. (2023) demonstrate significant negative abnormal returns for European banks around the day of the invasion due to their exposure to Russian financial sanctions and reputational damage. Martins and Cró (2024) also report negative stock price reactions for European airline companies due to air travel bans and increasing costs. Das et al. (2023) also document negative firm-level reactions in European mining, construction and manufacturing industries as a result of their dependence on Russia and Ukraine. The negative sectoral responses, in contrast with the positive returns reported in this study, clearly demonstrate that the Russia-Ukraine war had a differential impact across sectors. While several European sectors were negatively impacted by the economic spillovers of the conflict, the defense sector was the only one expected to profit from the expected escalation in European defense spending.

In general, the findings of this study are in line with previous research on the impact of geopolitical events on defense stocks. The significant positive abnormal returns in this study for European defense companies in the aftermath of the onset of the Russia-

Ukraine war are consistent with the results of Martins et al. (2025) and Adnan et al. (2026). The fact that other European sectors react negatively to the war also further supports the sector-specific nature of the financial effects of the war, as European defense firms have been the only ones to benefit from the expected increase in Europe's military spending.

6.2 Implications for Investors and Policymakers

The results of this paper have significant implications on investors as well as policy makers. For investors, the results suggest that defense stocks may not necessarily react the same as the broader market in geopolitical events. This may suggest that firms in the defense industry can contribute to the diversification of portfolios, especially in times of uncertainty.

Investors can view defense stocks as a potential investment that can be profitable because of the growth in military expenditure and subsidies. However, the results also show that the need to consider the risk factors for geopolitical events can result in market volatility. Therefore, investment decisions should take into account the return and the risk.

For policymakers, the findings suggest that geopolitical events and the markets are interlinked. This is measured by the positive reaction of the defense stocks, implying that the markets expect an increase in defense spending in wartime. This is a reflection of the role of government policy decisions in shaping investors' expectations and outcomes.

Finally, this paper suggests that it is important to understand industry specific factors in financial markets. Not all sectors are affected by geopolitical events, and the defense sector is unique in the sense that the conflict may have a beneficial impact on the market.

7 Conclusion

This study has examined the reaction of European defense firms to the outbreak of the war in Russia and Ukraine, which occurred on the date of the full-scale invasion of Ukraine on February 24, 2022. The study adopted the event study methodology to examine a sample of 16 listed European defense companies out of the SIPRI Arms Industry Database. We used two benchmark models, the Market Model and the Carhart Four-Factor Model, to calculate the expected returns, in order to assess the robustness of the results through multiple specifications. Event-day abnormal returns were examined at the stock and portfolio level, as well as several event windows, from one day to 21-day symmetric window [−10, +10].

The research question asked was: what was the impact of the war in Russia and Ukraine on the stock returns of European defense companies? The outbreak of the war generated significant positive abnormal returns for European defense stocks on the event day, as well as across all the event windows considered. The reaction was not entirely instantaneous, with a peak on day +2, which indicates that the investors revised their views on future military expenditures as new information unfolded in the days after the invasion. The positive and significant CAAR and CAR values across all event windows also confirm that this was an immediate and long-lived response. The results are robust to the model specification as they hold across the two models.

The implications of the results are clear. The start of the war seems to have been interpreted by investors as a signal of higher future European defense spending, resulting in a swift and persistent upward revaluation of European defense equities. This is supported by the increase in European defense budgets recorded in the years following the invasion. The analysis also highlights that the economic effects of the war were very specific, with the positive returns observed for the defense sector contrasting with the negative reactions reported for other European sectors (e.g. banking, airlines, and manufacturing) during the same time period.

In summary, this study offers evidence of a positive effect of the Russia-Ukraine war on European defense stocks, driven by investors' anticipation of an increase in future defense spending in Europe. The findings contribute to the growing literature on the financial effects of geopolitical events and highlight the unique position of the defense sector as a direct beneficiary of rising geopolitical risk.

Future research can build on this study in several ways.

To start with, the sample could be broadened to include defense firms in non-European countries in future studies to explicitly test the cross-regional effects of proximity to the conflict on the size and persistence of the market reactions. The differences found by Martins et al. (2025) between the European and Asian defense portfolio suggest that this diversity of regions is important and should be further studied.

Second, researchers may explore the cross-sectional explanatory variables of the abnormal return in the sample of the European defense more extensively. The firm-specific variables that could be used to explain the differences in the reactions and could provide more detailed information on the types of defense firms that would benefit most from geopolitical shocks include the proportion of defense-specific revenues, dependency on government contracts, exposure to NATO member states, and financial strength.

Third, future research may adopt volatility-based approaches such as GARCH or EGARCH models to study the dynamics of the risk of European defense companies in the event window and to complement the findings here using returns. Apergis et al. (2018) find that geopolitical risk has a larger and more persistent effect on the volatility of defense stocks than on returns, which may suggest that a volatility-based analysis may reveal more information on the reaction to the event than the event study method.

Finally, with the geopolitical environment constantly changing (as conflict in Ukraine persists, tensions in other areas escalate, and the European defense policy changes dramatically), future research could examine the effects of multiple or continuous geopolitical shocks on the long-term risk and return properties of the defense industry. The question of whether the defense sector will remain a geopolitical safe-haven investment in the long run in the face of geopolitical uncertainty, or whether the effect disappears as the market reaches a new equilibrium is an interesting empirical issue.

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Appendices

Appendix 1: Market Model Estimation Results for Sample Firms

Firm (Ticker)	Country	Market index used	α (Intercept)	β (Market sensitivity)	R^2	S.E. of regression
AIRBUS (R_AIRS)	France	CAC 40 RI (R_FRCAC40)	−0.000582	1.556259	0.4935	0.0144
BAE Systems (R_BA.)	UK	FTSE All-Share RI (R_FTALLSH)	0.00062	0.663982	0.2158	0.0096
Rolls-Royce (R_RR.)	UK	FTSE All-Share RI (R_FTALLSH)	−0.000030	2.101037	0.3279	0.0226
Thales (R_CSF)	France	CAC 40 RI (R_FRCAC40)	−0.000383	0.715862	0.3005	0.01
Dassault Aviation(R_AM)	France	CAC 40 RI (R_FRCAC40)	−0.000110	0.837491	0.2527	0.0132
QinetiQ (R_QQ.)	UK	FTSE All-Share RI (R_FTALLSH)	−0.000575	0.66444	0.0841	0.0165
Babcock (R_BAB)	UK	FTSE All-Share RI (R_FTALLSH)	0.000989	1.118889	0.0754	0.0295
Melrose (R_MRO)	UK	FTSE All-Share RI (R_FTALLSH)	−0.001719	2.183289	0.5433	0.0151
Thyssenkrupp (R_TKA)	Germany	DAX RI (R_DAX-INDX)	−0.000361	1.262311	0.1856	0.0243
Rheinmetall (R_RHM)	Germany	DAX RI (R_DAX-INDX)	−0.000115	0.789667	0.2733	0.0118
Kongsberg (R_KOG)	Norway	Oslo OBX RI (R_OSLOOBX)	0.00141	0.647139	0.1566	0.0137
Saab (R_SAAB)	Sweden	Sweden All-Share RI (R_SWSEALI)	−0.000556	0.627437	0.1499	0.0152
Safran (R_SGM)	France	CAC 40 RI (R_FRCAC40)	−0.001285	1.423596	0.417147	0.015405
Fincantieri (R_FCTI)	Italy	FTSE MIB RI (R_FTSEMIB)	−0.000357	0.935988	0.2422	0.0162
Leonardo (R_LDO)	Italy	FTSE MIB RI (R_FTSEMIB)	−0.000369	0.990452	0.2853	0.0153
Hensoldt (R_HAG)	Germany	DAX RI (R_DAX-INDX)	−0.000914	0.72178	0.1064	0.0192
Serco Group (R_SRP)	UK	FTSE All-Share RI (R_FTALLSH)	0.000123	0.790899	0.1909	0.012249

Notes: α denotes the intercept and β denotes the market sensitivity coefficient estimated using Ordinary Least Squares over the estimation window. R^2 measures the goodness of fit of the regression. S.E. of regression is the standard error of the regression used to calculate abnormal returns. Each firm's returns are regressed against its respective local market index as indicated.

Appendix 2: Carhart Four-Factor Model Estimation Results by Firm

Company	coeff. of c α	coeff. on Mkt_RF β	coeff.on SMB s	coeff.on HML h	coeff. on MOM u
r_ba	0.0005	0.6390	-0.2239	0.3418	-0.4291
r_ldo	-0.0008	1.4228	-0.1936	0.5311	-0.6178
r_airs	-0.0007	2.1579	0.4302	0.6467	-0.7434
r_csf	-0.0006	1.0435	0.0331	0.4724	-0.5661
r_am	-0.0003	1.1480	-0.1497	0.5220	-0.4858
r_rr	-0.0007	2.3621	0.6174	1.1199	-1.0982
r_sgm	-0.0015	2.0317	0.3919	0.7469	-0.9340
r_rhm	-0.0008	1.1292	-0.0167	0.4343	-0.3721
r_saab	-0.0010	1.0467	0.2177	0.2977	-0.1081
r_bab	0.0008	1.2132	-0.0354	0.4388	-0.7695
r_fcti	-0.0007	1.1013	-0.5722	0.3875	0.0041
r_srp	0.0002	0.7350	0.2381	0.1047	-0.1912
r_hag	-0.0009	1.1145	0.4994	-0.1795	-0.4619
r_qq	-0.0008	0.6439	0.1694	0.3379	-0.2651
r_mro	-0.0021	2.1641	0.0273	0.7186	-0.5603
r_kog	0.0013	0.6837	-0.0739	0.0250	0.3447

Notes: α denotes the intercept, β denotes the market risk factor coefficient (Mkt-Rf), s denotes the size factor coefficient (SMB), h denotes the value factor coefficient (HML), and u denotes the momentum factor coefficient (MOM). All coefficients are estimated using Ordinary Least Squares over the estimation window. The Fama-French and Carhart risk factors were converted from US Dollars to Euros prior to estimation.