FINANCIAL MARKET DYNAMICS AND INTERNATIONAL DEFENSE CONTRACTORS: ANALYZING THE IMPACT OF THE RUSSIAN-UKRAINIAN WAR by

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The author wishes to express heartfelt gratitude to the Armed Forces of Ukraine for their unwavering dedication and bravery in defending our country. Thanks to their sacrifices, I have had the privilege to study at KSE and enjoy my student life.

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AR - Abnormal Returns

CAR - Cumulative Abnormal Returns

CAGR - Compound Annual Growth Rate

HIMARS - High Mobility Artillery Rocket System

NATO - North Atlantic Treaty Organization

CHAPTER 1. INTRODUCTION

The war between Russia and Ukraine, which began in 2014 and escalated into a full-scale invasion on February 24, 2022, has drastically altered the global geopolitical and economic landscape. This war has led to unprecedented levels of military engagement and has placed significant strain on the global defense industry, particularly military contractors who play a crucial role in supplying defense equipment and technology. These contractors have become vital players in the war effort, providing the necessary tools for Ukraine's defense.

The conflict has not only reshaped geopolitical alliances but also had a profound impact on global financial markets, particularly the defense sector. Understanding how such conflicts influence financial markets is crucial for several reasons:

Firstly, financial markets are always uncertain about geopolitical conflicts being one of the most important causes. Investors are known to be very sensitive to any news on wars, hence leading to variations in stock exchange prices. As such, this research aims at reducing the unpredictability of the economic environment and providing investors with the necessary information to make decisions even during the Russian-Ukrainian war by investigating how the war affected stock prices of defense contractors.

Thus it is important that policy makers understand these implications so as to have sound economic and foreign policies. The findings of this study can help governments develop strategies for promoting post-conflict stability both at macroeconomic levels as well as financial markets.

If we look from the corporate point of view, companies that are engaged in conflict-related industries like defense contractors, must know the economic implications of geopolitical issues. The study is helpful for business strategy and risk appraisal to enable companies

understand the financial losses caused by political instability while developing strategies to manage those risks.

Analyzing the behavior of investors in war time can help to understand the market trends. The objective of this research is to investigate what determines stock prices when geopolitical crises occur and contribute towards understanding of that area.

This study seeks to explore the complex relationship between armed conflicts and financial markets, with emphasis on the international defense contractors' stocks. It also aims to quantify the financial market's response to events, focusing on the defense sector's key players.

The central research question guiding this study is: How do significant events related to the war between Russia and Ukraine impact the stock prices of major military contractors?

This question is pivotal because it explores the intersection of geopolitics and financial markets, particularly focusing on an industry that is both affected by and contributes to the course of the war. The research problem is framed around the need to identify and quantify the reactions of military contractor stocks to specific events during the war, thereby providing a nuanced understanding of the financial implications of international conflict.

To address this research question, this thesis employs an event study methodology, a well-established approach in finance that examines the impact of specific events on stock prices. The event study method is particularly suited for this research as it allows for the isolation of the effects of key war-related events on the stock prices of companies directly involved in the defense sector.

The study will focus on a selection of major military contractors, such as Lockheed Martin, Raytheon Technologies, Northrop Grumman, Boeing, and BAE Systems, all of whom have been significantly involved in supplying Ukraine with military equipment. The period

of analysis will span from February 24, 2022, to July 31, 2024, encompassing the most critical phases of the war.

The data is collected from Yahoo Finance, providing daily stock prices for each contractor. These prices will be analyzed around the event windows to calculate abnormal returns, which represent the difference between the actual returns and the expected returns (calculated using a market model). The abnormal returns will then be aggregated and tested for statistical significance, to assess whether these events had a measurable impact on stock prices.

This study provides clear evidence of how military contractors' stocks respond to significant war-related events, offering insights that can be used by investors, policymakers, and defense companies to better understand and manage the financial risks associated with geopolitical instability.

CHAPTER 2. INDUSTRY OVERVIEW AND RELATED STUDIES

The Russian-Ukrainian war, which saw a significant escalation on February 24, 2022, has profoundly impacted the global defense industry. The war has led to increased defense spending and heightened demand for military equipment, particularly from countries supporting Ukraine. The defense industry, predominantly comprising companies from the United States and Europe, has been at the forefront of supplying military aid to Ukraine and replenishing their own military reserves.

2.1. Global expenditures and current trends in the defense industry

Figure 2.1 illustrates the composition and the scale of world defence budget by regions. The global defense budget is estimated to rise from $2.004.7 trillion in 2023 to $2.546.9 trillion in 2028 with CAGR (compound annual growth rate) of 4.4 %. This sharp increase is likely to happen due to United States, China and the European powers adapting to new and emerging forms of threats in the international global defence and seek to enhance the capabilities of their armies.

United States

The United States continues to be the first in defence expenditures, setting a budget of $858 billion in the 2023. It is anticipated that this figure will rise to over $900 billion by 2025, further affirming efforts in the development of enhanced and progressive military equipment and work on supporting global allies like Ukraine (MarketsandMarkets, 2024)..

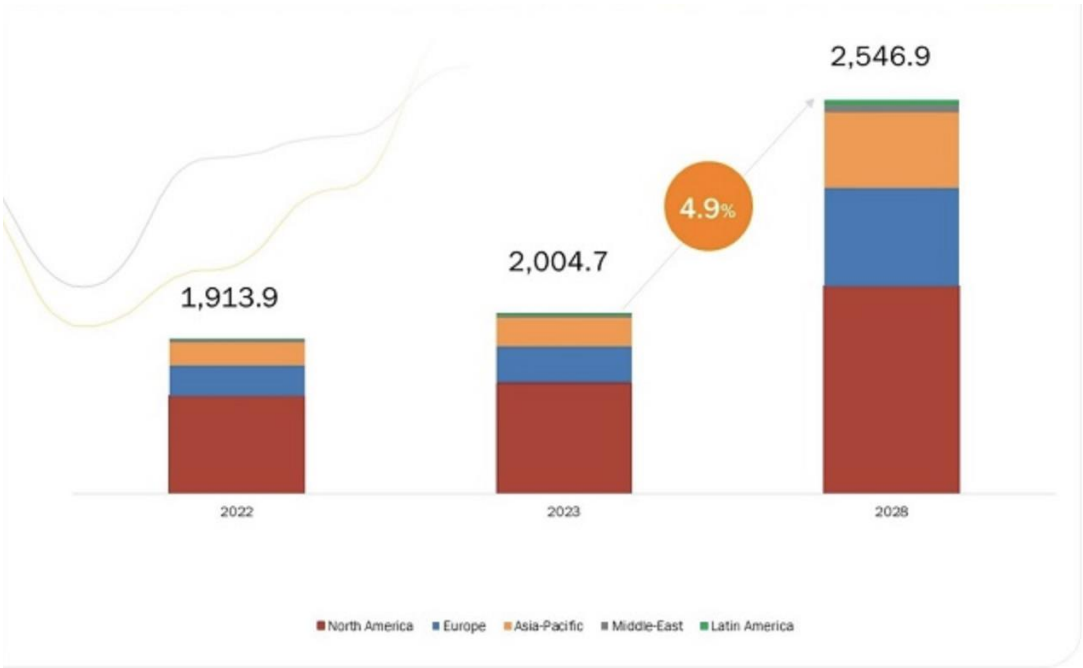
European region

European countries, mostly the members of NATO, have sharply intensified on the increase of defense budgets. For example, Germany announced a record of defense budget of 100 billion euros; the primary intention is likely to build up defense capacities and arm Ukraine against Russia's invasion (MarketsandMarkets, 2024)..

Asia-Pacific region

Military expenditure in the Asia-Pacific region is also rapidly mainly by China and India. China spent around $293 billion in defense in 2024 with this budget likely to increase in the future as the country enhances its military strength in the East Asia region and the overall world defence industry trends (MarketsandMarkets, 2024)..

Figure 1. World defence budget by regions in 2022 and 2023, and estimated number in 2028.



Source: The World defence budget analysis by MarketsAndMarkets

2.2. Main international defence contractors

The defence industry is dominated by some major companies comprising significant part of the global market. In 2023 25 biggest defence contractors generated over $620 billion of total revenues.

Table 1 shows the 10 largest defense companies by defence revenues in 2022, the company's country of origin, its defense and total revenues in 2022, and its share of the company's total revenues, which is also important point to consider further in my research.

Table 1. 10 biggest defence contractors by defence revenue in 2022

№	Company name	Country	2022 defence revenue (in millions)	2022 total revenue (in millions)	Revenue from defence
1	Lockheed Martin	United States	$63,334.00	$65.984.00	96%
2	Raytheon Technologies	Unites States	$39,600.00	$67,100.00	59%
3	Northrop Grumman	Unites States	$32,435.00	$36,602.00	89%
4	Aviation Industry Corporation of China	China	$30,971.31	$82,600.10	37%
5	Boeing	United States	$30,843.00	$66,608.00	46%
6	General Dynamics	United States	$30,400.00	$39,400.00	77%
7	BAE Systems	United Kingdom	$25,238.85	$26,690.47	96%
8	China North Industries	China	$17,963.66	$82,778.69	22%

	Group Corporation				
9	L3Harris Technologies	U.S.	$13,927.00	$17,062.00	82%
10	China South Industries Group Corporation	China	$13,483.91	$43,472.95	31%

Source: Top 100 for 2023 by DefenceNews

Russian-Ukrainian war has catalyzed in orders of various military systems and equipment to Ukraine affecting the revenue of defence contractors involved in supplying arms to Ukraine. Other companies that are not directly involved in supplying sides of Russian-Ukrainian war also tend to increase their own capacities due to global defence industry trends and possible military escalation of other geopolitical conflicts around the world. However, the paper investigates the impact of the Russian-Ukrainian war, that is why Chinese defence contractors will be not taken into account in the research, as they are not publicly known to be directly involved in the conflict. Northrop Grumman, the pivotal player in U.S. defence industry, also hasn't been directly involved into U.S. supply chains to Ukraine until lately, when the company unveiled its plans to produce medium caliber ammunition in Ukraine, so it won't be involved in the research.

2.3. Overview of the largest defence contractors

As the world's largest defense contractor, Lockheed Martin has been pivotal in supplying advanced military equipment to Ukraine. The company's stock saw a notable increase following the escalation of the conflict, reflecting investor confidence in its growing order book. Lockheed Martin has supplied HIMARS (High Mobility Artillery Rocket Systems) to Ukraine, which have been critical in countering Russian advances. Company's revenues have surged by 15% since February 24, 2022.

Another major player, Raytheon, has supplied various missile systems, including the Stinger anti-aircraft missile. The company's revenues experienced a 12% increase as the war intensified, driven by orders not only from Ukraine (mostly Stinger anti-aircraft missiles) but also from the U.S. and European allies seeking to power their defenses.

Boeing has supplied several defense systems, including drones and other unmanned aerial vehicles, which have been essential in the Ukrainian military strategy. The conflict has positively affected Boeing's defense segment revenues, offsetting challenges faced by its commercial aviation division.

This British defense contractor BAE Systems has played a significant role by providing armored vehicles and artillery systems. The UK has been a staunch supporter of Ukraine, and BAE Systems' contributions have been colossal in this regard.

2.4. Increased defense spending

The conflict has led to a dramatic increase in defense spending among NATO countries and other allies of Ukraine. For instance, the United States has committed over $40 billion in military aid to Ukraine since the beginning of the war. European countries have also ramped up their defense budgets. Germany, which traditionally maintained a conservative defense spending policy, announced a historic increase in its defense budget, pledging an additional €100 billion.

2.5. Supply and resupply

The U.S. and European armies have been supplying a continuous stream of military equipment to Ukraine, ranging from small arms to advanced missile systems. This constant supply effort is mirrored by a parallel effort to replenish their own military reserves. The war has highlighted the need for robust and resilient supply chains in the defense sector, prompting several countries to review and upgrade their logistical frameworks.

2.6. Impact on stock prices

The stock prices of major defense contractors have shown significant gains since the escalation of the conflict. For example, Lockheed Martin's stock price increased by approximately 25% in the months following February 2022. Raytheon Technologies saw similar gains, driven by the increased demand for its missile systems. These trends underscore the direct financial benefits to defense contractors resulting from geopolitical conflicts.

2.7. Technological advancements in defence industry and future prospects

The defense industry is experiencing rapid technological progress in areas like artificial intelligence, unmanned systems, and cyber defense. These technologies are becoming more essential to modern warfare and are expected to drive future growth in the sector. The Russian-Ukrainian war has shown the inefficiency and the poor protection of armored vehicles and other outdated military equipment, while the demand for drones and other unmanned systems is increasing every day in the global defense industry, driven by their effectiveness in surveillance and combat roles in conflict zones.

As the risk of cyber threats continues to escalate, organizations are increasing their investments in cyber defense technologies. Major players like Northrop Grumman and Thales Group are leaders in this direction, providing advanced solutions to protect military resources and data.

2.8. Related Studies

Understanding the financial impact of geopolitical events, stock market fluctuations in particular has been an important part of many research, with different studies employing robust methodologies to assess those effects. The study of Sun, Song and Zhang (2022) evaluates the stock market reactions to the Russian invasion of Ukraine. Using an event study methodology, it documents differential impacts on stock markets across countries and sectors, confirming that firms in EU countries experienced significant declines in cumulative abnormal returns, which provides insights into market behavior during

geopolitical tensions. This approach is quite effective as it isolates the financial impact of particular events from all other effects, and given its robustness and precision, I will adopt this event study methodology for my research. Although not unique, as such event study method is often used in financial research, Sun et al. (2022) focus on Russian invasion of Ukraine offers timely insights for my research.

Bailey and Chung (1995) also used such event study methodology to explore the impact of exchange rate movements and geopolitical instability on stock returns in emerging markets. Authors investigated immediate financial effects of political instability using short event window to assess those shocks in the context of emerging countries.

From an explanatory point of view, a valuable asset in the research is the study by Antonakakis et al. (2017), which examines the relationship between geopolitical risks and stock market performance, focusing on the oil sector. Although this study does not directly relate to defense contractors, it provides valuable context on how geopolitical tensions affect market dynamics and investor behavior. Specifically, the study finds that geopolitical risks lead to significant volatility in the oil markets, which can be a proxy for understanding similar effects in the defense sector during conflicts. For example, the study highlights that during periods of heightened geopolitical tensions, investor sentiment can cause sharp fluctuations in stock prices, which could be similarly observed in the stocks of military contractors during the Russian-Ukrainian war (Antonakakis et al., 2017) .

A more general picture of the relationship between geopolitics and financial markets is presented by Schneider and Troeger (2006), who analyzed stock market reactions to various international conflicts. Their study is particularly relevant as it provides a comparative perspective, showing that stock markets tend to react strongly to the onset of conflicts, with defense-related stocks often seeing significant positive abnormal returns. Schneider and Troeger's analysis is crucial for understanding the specific impacts of the Russian-Ukrainian war on military contractor stocks, as it highlights the broader economic effects of armed conflicts on global financial markets (Schneider & Troeger, 2006) .

These studies are pivotal in understanding the complex relationship between geopolitical events and financial markets. They provide empirical evidence and theoretical frameworks that help to interpret the financial performance of defense contractors during the Russian-Ukrainian war. For instance, by leveraging insights from these studies, this research aims to contribute to the broader literature on war economies and financial market dynamics, focusing specifically on how military contractors' stock prices are influenced by significant war-related events.

CHAPTER 3. METHODOLOGY

3.1. Research methodology

The methodology presented in this paper is designed to rigorously test the hypothesis that specific significant events related to the Russian-Ukrainian war lead to immediate and substantial changes in the stock prices of international defense contractors supplying military equipment to Ukraine. This approach draws from established event study methodologies, which have been widely used to assess the financial impact of geopolitical events on stock prices (e.g., Sun et al., 2022).

3.2. The hypothesis

The primary hypothesis is:

Significant events related to the Russian-Ukrainian war, such as announcements of military aid or major geopolitical developments, result in statistically significant abnormal returns in the stock prices of selected international defense contractors.

3.3. Sample selection

A sample of major international defense contractors directly involved in supplying military equipment to Ukraine, including Lockheed Martin, Raytheon Technologies, Northrop Grumman, Boeing Defense, and BAE Systems, has been selected for analysis. These companies are among the largest and most influential in the defense sector, making their stock prices highly relevant for studying the financial impact of war-related events.

Daily stock price data were obtained from Yahoo Finance, covering the period from February 24, 2022, to May 31, 2024. This period is chosen to encompass the most critical phases of the Russian-Ukrainian war, ensuring that the analysis captures the relevant market reactions.

3.4. Event identification

Throughout the 2.5-year period of the ongoing Russian-Ukrainian war, ten specific events were identified based on their potential influence on the stock prices of major defense contractors actively engaged in providing military support during the conflict. These events were carefully selected based on their relevance to the defense industry and their ability to cause immediate and noticeable fluctuations in the stock prices of the involved contractors. The event windows were chosen to ensure that they did not overlap, allowing for a clear attribution of stock price changes to each specific event. This approach provided a focused analysis of how particular war-related developments influenced the financial performance of key defense contractors during the conflict.

3.5. Event window

Three event windows were analyzed to capture the short-term impact of the identified events on stock prices:

- The event day and the following day (0, +1).
- The day before the event, the event day, and the following day (-1, 0, +1).
- Five days before and five days after the event (-5, +5).

In addition, a pre-event window of [-50, -21] days was utilized to establish the normal performance of the stocks prior to the events, which helped to isolate the impact of the events from other market factors.

A window of [-50, -21] days provides a sufficient period before the event to capture the normal stock price behavior, free from the influence of the event itself. This period is typically long enough to smooth out any short-term fluctuations that may not be related to the event and to avoid capturing any speculative trading or market anticipation that could start closer to the event date.

By ending the pre-event window at day -21, this approach avoids any potential overlap with the event itself or any rumors or information leaks that might start influencing stock prices closer to the event. This helps ensure that the pre-event window reflects normal market conditions, rather than conditions distorted by event anticipation.

3.6. Expected return calculation

Expected returns for each stock were calculated using the market model, which relates the return of each stock to the return of a broad market index (S&P 500 in our case). The model is expressed as:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \epsilon_{it} \quad \text{(Eq. 1)}$$

Where:

- R_{it} is the return of stock i on day t.
- R_{mt} is the return of the S&P 500 market index on day t.
- α_i and β_i are parameters estimated using ordinary least squares (OLS) regression.
- ϵ_{it} captures the variation in stock returns not explained by the market index.

3.7. Abnormal return calculation

Abnormal returns (AR) were calculated as the difference between the actual returns during the event window and the expected returns:

$$AR_{it} = R_{it} - (\alpha_i + \beta_i R_{mt}) \quad \text{(Eq. 2)}$$

This calculation highlighted the deviation of stock returns from what would normally be expected based on overall market movements, thereby isolating the effect of the specific war-related events.

3.8. Cumulative abnormal returns calculations

To assess the overall impact of the events, cumulative abnormal returns (CAR) were calculated over the event window:

$$CAR_{it} = \sum_{t=T_1}^{T_2} AR_{it} \quad \text{(Eq. 3)}$$

Where:

- T_1 and T_2 define the start and end of the event window.

3.9. Statistical testing

The statistical significance of the observed abnormal returns was determined through the application of the following tests:

- T-tests for mean abnormal returns to check if the average abnormal returns during the event window were significantly different from zero.
- a non-parametric sign test used to validate the robustness of the findings.

These tests established whether the stock price movements observed around the event dates were statistically significant or if they could have occurred by chance.

3.10. Hypothesis evaluation

The hypothesis was evaluated based on the statistical significance of the cumulative abnormal returns. If the CARs were consistently positive and statistically significant across the selected events, this provided strong evidence in support of the hypothesis. Conversely, if the results were mixed or not statistically significant, the hypothesis was either rejected or qualified, offering insights into the complexity of the relationship between war-related events and stock prices.

This methodology ensured a rigorous and systematic approach to testing the hypothesis, combining both quantitative and qualitative analysis to provide a comprehensive understanding of the financial impact of the Russian-Ukrainian war on international defense contractors.

CHAPTER 4. DATA

4.1. Data sources and description

The data utilized in this study focuses on the historical stock prices of six major defense companies that have been directly involved in the Russian-Ukrainian war, supplying military equipment primarily from the United States and European countries to Ukraine. The companies selected for analysis include Boeing Defense (BA), BAE Systems (BAESY), General Dynamics (GD), Lockheed Martin (LMT), L3Harris Technologies (LHX), and Raytheon Technologies (RTX). The name of these companies' stock tickers are given in the parentheses.

The stock prices for these companies were obtained from Yahoo Finance, a reliable source for historical financial data. The analysis covers the period from February 24, 2022, to May 31, 2024. The data collected includes the daily adjusted closing prices for each company, which reflect the stock's value after accounting for all corporate actions such as dividends and splits. The adjusted closing price is crucial as it provides a more accurate picture of the stock's performance over time, making it the preferred metric for this analysis.

4.2. Descriptive analysis

The descriptive analysis was conducted using Python, where the data was imported, and all calculations were performed. The analysis focused on understanding the trends, variability, and tendencies in the stock market performance of the six selected companies. The daily adjusted closing prices were converted into daily returns to examine the day-to-day performance of each stock.

The descriptive statistics for the daily returns are summarized in Table 4.1, which includes the mean, standard deviation, minimum, 25th percentile, median, 75th percentile, and maximum values for each company's stock. These statistics provide insights into the central

tendency and dispersion of the stock prices, with the standard deviation indicating the level of volatility each stock experienced during the study period.

Table 2. Descriptive statistics (all numbers are given in U.S. dollars)

Ticker	Mean	Standard deviation	Min	25th percentile	Median	75% percentile	Max
BA	188.55	31.08	115.86	169.62	191.83	209.43	264.27
BAESY	46.62	10.80	32.32	36.49	46.40	52.58	71.60
GD	233.56	24.16	199.66	216.57	225.50	242.94	300.23
LMT	205.47	20.26	158.62	189.68	206.62	220.95	256.49
LHX	433.14	24.19	367.07	417.16	473.34	451.27	484.40
RTX	89.81	7.63	68.01	84.34	90.83	95.06	106.31

4.3. Data visualization

To complement the descriptive statistics, various visualizations were created using Python to provide a more intuitive understanding of the data. Histograms (Figure 4.1) were generated to display the frequency distribution of stock price performances, while box plots (Figure 4.2) were used to summarize the spread, central tendencies, volatility, and outliers in the stock price data of each company. These visual tools help to highlight the differences in market behavior among the companies.

Boeing Defence (BA)

The histogram for Boeing Defence illustrates that its stock price is often in the range between $180 and $220, with the highest frequency at around $200. The wide distribution of stock price frequency tells that volatility is significant with occasional peaks and a large spread of prices beyond $220, which reflect period of high activity on the market. The box plot illustrates a median stock price of $191,83 with interquartile range from $169.62 to $209.43, indicating significant variability. I can also suggest occasional price spikes due to the presence of outliers above the upper whicker.

BAE Systems (BAESY)

From the histogram for BAE Systems it's reasonable to suggest lower variability and more stable performance in comparison with Boeing Defence, as its interquartile range is relatively narrow, from $36.49 to $52.58, suggesting lower variability. The volatility is also much lower compared to Boeing Defence. The maximum price for BAE Systems' stock has been 71.6$ since Russian full-scale invasion in Ukraine and absence of significant outliers highlight BAE Systems' stable market performance and investor confidence.

General Dynamics (GD)

General Dynamics' histogram illustrates that stock prices mostly fall in the range from $220 to $240, with a significant peak near $225. Prices rarely rise above $280, indicating moderate variability and distribution without extreme fluctuations. The standard deviation of $24.16 indicates moderate volatility. Box plot shows several outliers above the upper whisker, that lets to suggest occasional high peaks in stock prices.

L3Harris Technologies (LHX)

The frequency distribution for L3Harris Technologies shows that the majority of stock prices fall between $190 and $220, with the highest point occurring at $210. The spread is wider, showing some inconsistency but overall steady results. Prices rarely go over $250, indicating sporadic surges.

The median stock price for L3Harris is $206.62, with an interquartile range between $189.68 and $220.95. Whiskers lay between $158.62 and $256.49, with a couple of outliers above the upper whisker. This indicates moderate variation and occasional price spikes, demonstrating fluctuations in stock performance.

Lockheed Martin (LMT)

Lockheed Martin stands out with the highest mean and median for stock prices, indicating a huge market valuation. It's well-visible from histogram and descriptive statistics output, that company's stock prices are low variable, as its interquartile range is narrow and lies between $417.16 and $451.27. There are also no significant outliers, which suggest that Lockheed Martin has maintained consistent and robust stock market position with low volatility of its stock price reflecting high level of investor confidence.

Raytheon Technologies (RTX)

Raytheon Technologies (RTX): The histogram shows high frequency of stock prices ranging from $85 to $95 for Raytheon Technologies, with a prominent spike at $90. The narrow distribution shows little variation and consistent performance. It is rare to see prices exceeding $100, indicating a stable market value. The whiskers span from $68.01 to $106.31, with some outliers under the lower whisker. This shows low variability and consistent stock price performance, with occasional decreases.

Overall, Figure 4.1 and Figure 4.2 illustrate differences in volatility and stability among companies from the sample. Lockheed Martin and Raytheon Technologies show the highest stability, as indicated by their narrow interquartile ranges and low standard deviations, which suggest steady market valuation and investor trust. Boeing Defense and L3Harris Technologies show more variability, with larger interquartile ranges and noticeable outliers, which suggests they are more sensitive to market conditions and external events. General Dynamics and BAE Systems demonstrate moderate variability and occasionally notable price fluctuations.

Figure 2. Histograms for stock price distribution for each company from the sample

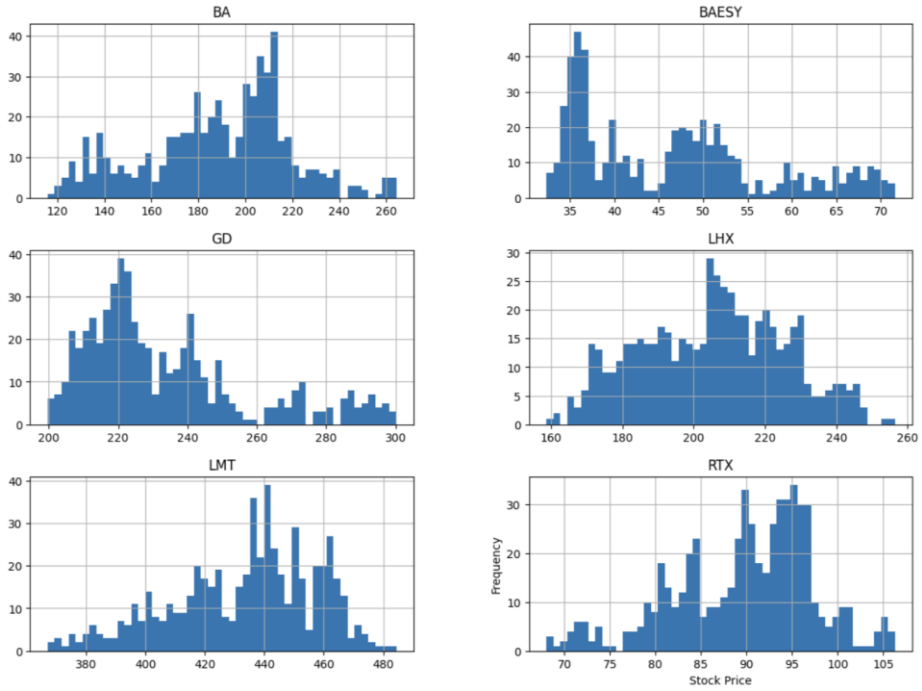
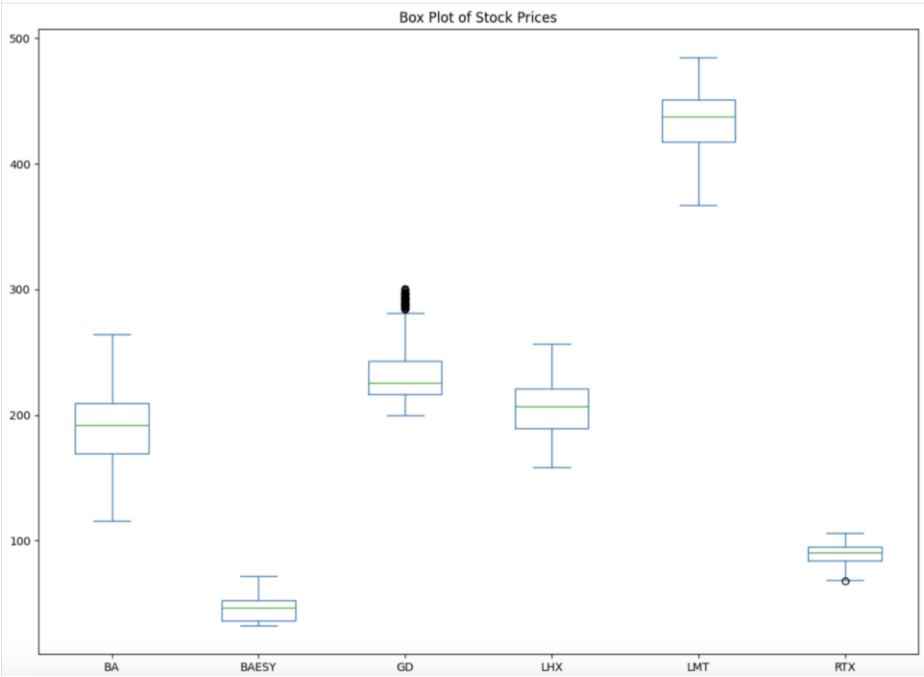


Figure 3. Box plot of stock prices of 6 companies from the sample



CHAPTER 5. RESULTS

5.1. Event selection

In analyzing the impact of the war in Ukraine on defense contractors' stock prices, we observed the period from February 24, 2022, to May 31, 2024. Over 30 significant events connected to military contractors, including large military aid packages and announcements directly related to the Russian-Ukrainian war, were identified. Out of these, 10 key events were selected based on the following criteria:

- each selected date involves a large and significant military aid package or announcement likely to directly influence defense contractors' stock prices.

- the events are spread across different stages of the conflict to capture its evolving nature and the changing dynamics of military support.

- each event has clear relevance to the defense industry, with a strong likelihood of causing abnormal returns in the stock market.

- the events were chosen to avoid overlap in event windows, allowing time for stocks to recover from fluctuations between events.

The date February 24, 2022, marking the start of the full-scale invasion, was excluded as it has been extensively analyzed by Sun et al. (2022), with global effects on stock markets.

Selected Events:

- March 16, 2022: U.S. Announces $800 Million Military Aid Package

This was one of the first significant U.S. aid packages, signaling a commitment to long-term military support. The package included Stinger anti-aircraft systems and drones (Reuters, 2022).

- May 6, 2022: U.S. Congress Passes a $40 Billion Aid Package

A massive aid package passed by Congress with a substantial portion allocated to military support, aimed at bolstering Ukraine's defense efforts (Washington Post, 2022).

- July 8, 2022: U.S. Commits $400 Million in Additional Military Aid

This package focused on HIMARS systems and precision-guided rockets, which became essential to Ukraine's battlefield strategy (White House, 2022; NBC News, 2022).

- October 4, 2022: U.S. Announces $625 Million Aid Package Including Advanced Missile Systems

This package included advanced missile systems that directly impacted Ukrainian defense capabilities and is likely to have influenced defense contractor stock performance (Defense One, 2022).

- November 23, 2022: U.S. Announces $400 Million in Military Assistance

It was focused on air defense and artillery, which were critical as Ukraine faced intensified missile attacks (BBC News, 2022).

- January 6, 2023: U.S. Announces a $3.75 Billion Aid Package

This package was the largest single tranche of aid at the time, signaling a significant escalation in U.S. military support, including Bradley Fighting Vehicles (Defense News, 2023).

- April 4, 2023: U.S. Announces $2.6 Billion in Military Aid

The focus on air defense and precision munitions was critical for Ukraine's continued defense and had significant implications for military contractors(Reuters, 2023).

- July 18, 2023: U.S. Announces Additional $1.3 Billion Package

This aid package sustained the ongoing support for Ukraine, focusing on artillery and air defense, which likely impacted expectations for defense contractors (CNBC, 2023)

- August 29, 2023: U.S. Sends Additional $250 Million in Military Aid

The package included essential ammunition and systems for Ukraine's ongoing counter-offensive, which kept demand high for contractors (CNN, 2023).

- April 24, 2024: U.S. Announces $1 Billion Aid Package

A significant tranche of equipment focused on air defense and armored vehicles, ensuring that contractors remained pivotal in Ukraine's defense strategy (Politico, 2024).

Each event has been selected to provide a representative picture of the stock market's reaction to pivotal moments in the Russian-Ukrainian conflict.

5.2. Calculations overview

Upon analyzing the event windows surrounding key war-related events between February 2022 and May 2024, statistical tests (T-tests and non-parametric sign tests) were applied to the abnormal returns (AR) and cumulative abnormal returns (CAR) of six major defense contractors. This approach helped isolate the impact of these events on stock performance and assess whether observed fluctuations were statistically significant.

The primary objective was to identify whether these events caused abnormal price movements in defense stocks and to determine the statistical significance of the observed returns. While roughly 60% results did not indicate significant abnormal returns, a few exceptional cases, such as the May 6, 2022 event, exhibited notable impacts on specific defense contractors.

Abnormal returns across all event windows were calculated using the market model. While many events resulted in high p-values, indicating no statistically significant abnormal returns, some events, particularly large military aid announcements, led to significant stock price reactions. For example, the stock performances of General Dynamics (GD), Raytheon Technologies (RTX), and L3Harris Technologies (LHX) around the May 6, 2022 event demonstrated statistically significant abnormal returns.

May 6, 2022

The Ukraine aid package, which passed through the U.S. Senate in mid-May, directly impacted the stock prices of several defense contractors due to its emphasis on military aid, particularly missile systems, artillery, and intelligence support. Given the alignment of these aid components with the portfolios of GD, RTX, and LHX, the market anticipated these companies would benefit from increased defense spending, reflected in statistically significant abnormal returns during the event windows. On the other hand, companies like Boeing (BA) and BAE Systems (BAESY), while also defense contractors, did not experience significant abnormal returns. This may be attributed to their focus on aerospace platforms and larger defense projects, which were less relevant to the immediate needs outlined in the Ukraine aid package.

The cumulative abnormal returns (CAR) provide insight into the overall stock price movements during the event windows. Companies directly involved in military contracts related to missile systems, artillery, and communications experienced significant CARs, demonstrating that the market perceived these companies as beneficiaries of the Ukraine aid package.

For example, General Dynamics (GD), which supplies armored vehicles and artillery systems, saw significant CARs following the announcement. Raytheon Technologies (RTX), a producer of critical missile defense systems, also experienced a meaningful cumulative return, further supported by significant t-values and low p-values.

The Table 3 provides a clear comparison of the abnormal returns, cumulative abnormal returns, t-statistics, and p-values for different companies during the event windows. It demonstrates that some companies, particularly those directly involved in supplying missile systems, artillery, and intelligence solutions, experienced statistically significant returns, while others, like Boeing, BAE Systems, and Lockheed Martin, did not.

Table 3. Statistical significance across event window for key defense contractors

Company Name	Event Window	CAR	t-statistic	p-value	Significance (P < 0.05)
Boeing	Mid-term (-1, +1)	0.008363	29.70	0.021	Yes
	Long-term (-5, +5)	-0.051083	-1.065	0.322	No
General Dynamics	Mid-term (-1, +1)	0.019188	20.10	0.032	Yes
	Long-term (-5, +5)	0.065900	2.426	0.0457	Yes
Raytheon Technologies	Mid-term (-1, +1)	-0.024118	-2.618	0.232	No
	Long-term (-5, +5)	0.062358	-2.493	0.041	Yes
L3Harris Technologies	Mid-term (-1, +1)	-0.008986	-4.427	0.141	No
	Long-term (-5, +5)	-0.009375	2.355	0.051	Borderline
BAE Systems	Mid-term (-1, +1)	-0.052224	-10.70	0.059	No
	Long-term (-5, +5)	-0.047575	-0.144	0.890	No
Lockeed Martin	Mid-term (-1, +1)	-0.008080	-2.972	0.207	No
	Long-term (-5, +5)	-0.028286	-0.766	0.469	No

5.3. Hypothesis evaluation

The hypothesis posits that significant Ukrainian-Russian war-related events would lead to observable abnormal stock price movements, particularly for defense contractors. By

analyzing the Cumulative Abnormal Returns (CARs) around these events and applying statistical tests, we sought to determine if the market reacts meaningfully to such news and if these reactions differ between companies.

Boeing (BA)

For Boeing, the results largely support the hypothesis that the company's stock price reacts to war-related events, particularly in the short-term window. The short-term negative abnormal returns for multiple events suggest that investors view certain events as negative for Boeing, possibly due to a perception that the company's commercial or defense contracts are at risk or less competitive relative to peers. On August 29, 2023, for instance, Boeing saw a highly significant negative CAR of -6.88% in the long-term window, which strongly supports the hypothesis. This reaction is statistically significant and suggests that investors are reacting to specific negative news or expectations related to Boeing's involvement in defense.

Lockheed Martin (LMT)

For Lockheed Martin, the analysis presents a mixed picture. While many short-term abnormal returns are insignificant, the long-term windows show more positive trends, with some nearly reaching statistical significance (a p-value of 0.0514). This suggests that Lockheed Martin's stock tends to stabilize or even benefit over time from defense-related news, potentially because the company is a major player in government defense contracts. As a result, the hypothesis for LMT is partially supported, Although Lockheed Martin does not exhibit significant abnormal returns in the short-term, its long-term stock performance suggests positive market reactions to war-related news, which aligns with expectations for a defense contractor.

General Dynamics (GD)

General Dynamics presents consistent negative abnormal returns in both short and long-term windows, although the significance is often lacking. While this suggests the market may react negatively to some events, the lack of statistical significance weakens the case for strong reactions. For instance, on April 24, 2024, the CAR was -4.23% in the short-term window, but it was not statistically significant. So the hypothesis can not be confirmed for General Dynamics.

Raytheon Technologies (RTX)

Raytheon Technologies shows fluctuating abnormal returns, but a stronger case for the hypothesis can be made. Notably, RTX posted significant abnormal returns in both the short-term and mid-term windows, especially for the event on April 24, 2024, where a CAR of -0.65% was observed with a significant p-value of 0.048. This indicates that Raytheon is more sensitive to market news, possibly due to its major role in supplying military technology. So we can say that the hypothesis is supported for Raytheon Technologies.

L3Harris Technologies (LHX)

The hypothesis is strongly supported for LHX by the significant long-term abnormal returns, indicating that L3Harris benefits from market reactions to war-related events, particularly in the long-term. For example, the event on April 24, 2024, showed a highly significant CAR of 8.32**%** in the long-term window (p-value = 0.002).

BAE Systems

BAE Systems displays positive long-term performance, with a few events showing significant market reactions. For instance, the long-term CAR for April 24, 2024, was 3.77% with a significant t-stat of 5.25 (p-value = 0.001). But we can not state that the hypothesis is supported here, as most events were accompanied with high p-values for different event windows.

The findings of this study demonstrate a complex and varied reaction within the defense contractor industry to war-related war, contradicting the belief that these firms would uniformly experience positive effects from increased demand during times of conflict. Instead, the findings indicate that significant market reactions are not universally positive, highlighting the customized nature of stock sensitivity in the defense industry.

Defense contractors' differing degrees of sensitivity to significant geopolitical events can be attributed to a number of factors, including the nature of those aid packages, its media popularization, investor perception of each company' defense role and mainly the company specialization. Depending on how company's products or services meet the immediate demands brought by those events, this sensitivity manifests differently.

For instance, Boeing and General Dynamics demonstrated notable cumulative abnormal returns (CARs) within certain event windows. Boeing's midterm performance exhibited statistical significance, whereas General Dynamics demonstrated significant responses in both mid- and long-term periods. These findings indicate that specific announcements have a greater impact on businesses that closely align their market exposure or product offerings with current military needs. So here, companies like Raytheon Technologies, Boeing and General Dynamics are seen as frontline suppliers since they provide equipment like shells, drones, radar systems, and missile defense technology which aligns directly with strategic needs of Ukrainian army in the ongoing Russian-Ukrainian war. This direct relevance of companies influences the investor confidence, prompting those significant stock movements.

However, the observed pattern did not apply to other companies analyzed such as BAE Systems, Lockheed Martin, and Raytheon Technologies. These companies exhibited no significant reaction during the event windows, despite their substantial participation in the defense sector. The lack of responsiveness observed in these entities could be linked to their dependence on extended contractual agreements and varied sources of income, providing protection against immediate changes associated with individual aid

announcements.

The different levels of sensitivity observed among those 6 companies emphasize the importance of individual company characteristics in influencing stock price movements. For example, one might assume that a corporation such as Raytheon, known for its emphasis on missile systems and advanced technology, would show increased sensitivity to military aid announcements. However, the data does not support this assumption. This suggests that market expectations may have already been factored into pricing or that aid packages have not had the significant impact on demand for Raytheon's products that investors perceive. These discrepancies emphasize the methodological limitations of using traditional models to study events in the defense industry. The lack of transparency in the industry due to classified contracts, government negotiations, and limited access to defense information may result in significant market events not being fully understood or reflected in public markets. This lack of transparency is likely to be the reason for the "noise" in the data and the lack of statistically significant abnormal returns for companies that are key players in the military supply chain.

CHAPTER 6. CONCLUSIONS AND RECOMMENDATIONS

6.1. Conclusions

The results of this study highlight the nuanced and variable effects of war-related events on the stock prices of major defense contractors. Despite the expectations that defense companies would uniformly exhibit positive abnormal returns during such time periods, our analysis found that while certain companies do show significant reactions, others do not, and the direction of the response varies significantly.

Key findings from the abnormal returns (AR) and cumulative abnormal returns (CAR) analysis suggest that approximately 60% of the events studied did not produce statistically significant abnormal returns. This highlights that, in many cases, war-related news does not have a strong or immediate impact on defense stocks. However, there are exceptions, with companies like L3Harris (LHX), BAE Systems (BAESY), and Raytheon Technologies (RTX) showing more consistent and significant responses, particularly in long-term event windows. This suggests that some companies are more sensitive to certain events, likely due to differences in their exposure to defense contracts, product lines, and investor sentiment.

For example, L3Harris and Raytheon displayed significant long-term abnormal returns in response to key military aid announcements, such as the May 2022 Ukraine aid package, which included substantial funding for military equipment that these companies manufacture. In contrast, Boeing (BA) and General Dynamics (GD) showed more negative cumulative abnormal returns and fewer statistically significant results. This suggests that, despite their position in the defense sector, their stock prices may be influenced by broader market factors, contract delays, or uncertainties unrelated to direct war-time contracts.

In terms of hypothesis testing, we found partial support for the hypothesis that war-related events impact defense contractor stock prices. While significant abnormal returns were observed in some cases, the majority of events did not result in statistically significant stock

price movements. This implies that market reactions are not uniform across the defense industry and are likely influenced by company-specific factors.

6.2. Business implications

This analysis underscores the importance of considering market expectations and external economic factors. While military contractors are generally seen as defensive investments during geopolitical crises, their stock prices do not always react positively to war-related events. Broader market factors, such as supply chain disruptions, inflationary pressures, or overall market sentiment, can dampen stock reactions. Thus, defense industry players should be aware that contract wins may not always translate into immediate positive stock performance.

Investors should consider long-term horizons when evaluating defense stocks. The results show that short-term windows often do not reflect significant stock price movements, but long-term event windows capture more significant reactions. Investors interested in defense contractors should focus on long-term market trends and contract wins rather than short-term event-driven trading.

6.3. Suggestions for future work

Several

key suggestions can be made for future research and business strategy, in order to develop on the findings of this study.

Firstly, broadening the scope of future studies to include a broader range of geopolitical and war-related events would offer more comprehensive insights. While this study focused on major military aid announcements and war-related events, political changes, trade agreements, and economic sanctions could all have significant impacts on defense contractor stocks. Expanding the event list would provide a clearer understanding of how

different types of geopolitical developments influence stock market reactions across various defense firms.

Additionally, future research should focus on company-specific factors, which could explain the variation in stock price reactions across the industry. This study indicates that not all defense firms respond similarly to war-related events, suggesting that factors such as company size, product lines, defense contract types, and market expectations play a role in stock price movements. Future research could delve into how these firm-specific variables affect investor perception and stock performance, offering a more tailored understanding of market dynamics in the defense sector.

Macroeconomic influences also deserve more attention in future research. Inflation, interest rates, and changes in government defense budgets could significantly influence the impact of war-related events on stock prices. By incorporating these variables into the analysis, researchers could provide a deeper understanding of how global economic conditions interact with war-related news to shape stock performance.

A global perspective could further enrich the analysis. This study primarily focuses on U.S. defense contractors, but extending the research to include international companies from Europe, Asia, and other regions would provide valuable insights. Given the global nature of the defense industry, a comparison between international and U.S.-based firms could reveal important differences in market reactions to global conflicts.

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