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ICADE

THE MODERN INVESTOR'S DILEMMA: INVESTING IN DEFENSE COMPANIES

AN ANALYSIS OF THE IMPACT OF WAR CONFLICTS ON THE RISK-RETURN RELATIONSHIP IN THE U.S. DEFENSE INDUSTRY

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Abstract.

In the context of growing geopolitical instability involving powerful nations, the global defense sector has increasingly attracted investor interest, prompting a reallocation of capital towards military and security-related equities. Given the United States' role as a dominant force in the aerospace and defense industry and its indirect involvement in recent conflicts such as the Russia–Ukraine war and the Israel–Hamas escalation this study analyzes how these geopolitical events have impacted the risk-adjusted returns across different subsectors of the U.S. Aerospace and Defense industry. By comparing the performance of subsectors such as prime system contractors, cybersecurity, communication technologies, and unmanned systems, the research identifies which areas have benefited most from the evolution of modern warfare and heightened global tensions.

This work contributes to the existing literature on the financial implications of geopolitical conflict by offering a more granular, subsector-level perspective. The findings show that no conflict impacts all subsectors equally. Despite the emergence of new players, traditional prime contractors continue to lead in risk-return efficiency, while technology and communication-focused companies show promising growth but remain characterized by high volatility.

Keywords

War conflicts, arms, military, geopolitical, Ukraine, Israel, Defense Industry, United States, volatility, returns, Sharpe ratio, investor, technology, manufacturing, budget, risk-free, logarithmic returns.

Table of Contents

I. INTRODUCTION

The global defense industry is strategically, economically, and politically significant, profoundly influencing international relations, global stability, and economic performance. Recent geopolitical developments, notably the war in Ukraine, tensions across the Taiwan Strait, conflicts in the Middle East, and security concerns in the Asia-Pacific region, have significantly reshaped global defense spending patterns and arms trade dynamics (Wezeman et al., 2025).

Since the late days of February 2022, when Russia initiated a military offensive into Ukraine, defense stocks have garnered heightened attention from investors (Zhang et al., 2022). Before this development, many asset managers and financial institutions had adopted restrictive policies or screening mechanisms that disfavored the defense sector, often due to Environmental, Social, Governance (ESG) considerations that placed arms manufacturing in a controversial category (Mitkow et al., 2022). However, the abrupt realization that European stability was more fragile than assumed, followed by dramatic surges in defense spending across the continent, triggered a reevaluation of arms and defense companies as an investment category. Nations such as Germany, which had previously maintained relatively constrained defense budgets for decades, committed an additional €100 billion to modernize their armed forces in the immediate aftermath of the Ukraine invasion (Blum, 2019). NATO members have demonstrated a rapid and substantial increase in their defense expenditures, often surpassing the recommended benchmark of 2% of GDP1[1]. This escalation in defense expenditures signaled an extraordinary budgetary dedication to defense, unparalleled since the Cold War era.

In order to contextualize the present moment, it is essential to refer to the most authoritative source of quantitative and qualitative information on the arms trade. The yearbook published by SIPRI (2025) states that in 2024, worldwide military expenditures reached a record high, surpassing $2.2 trillion. This growth indicates an approximate 19% increase from a decade prior, underscoring a persistent upward trend in global defense investments. Government contracts represent a pivotal element of the global defense industry, characterized by their extensive procurement cycles, long-term contracts, competitive bidding processes, and rigorous performance requirements. Regarding the transatlantic context, the United States continues to dominate the global arms market. According to the Stockholm International Peace Research Institute (Wezeman et al., 2025),

[1] See “Defence Expenditure of NATO Countries (2014-2024) “of Nato Press Release

between 2020 and 2024, the United States maintained its position as the predominant global arms exporter, capturing a substantial 44% market share. Major defense contractors such as Lockheed Martin, Raytheon Technologies, and Northrop Grumman depend on domestic contracts from the Pentagon and substantial foreign military sales to ensure consistent revenue streams (Sacknoff, 2023). During the period spanning 2022 and the early months of 2023, these corporations demonstrated robust performance, outperforming numerous broad market indices. According to Bouri et al. (2024), this surge can be attributed to a "flight-to-arms," analogous to the more familiar "flight-to-quality." In this scenario, portfolio managers perceive weapon contractors as being less economically sensitive and more reliant on robust, long-term government procurement cycles, particularly during periods of intense geopolitical uncertainty. Concurrently, the ethical discourse surrounding "controversial" industries within the ESG domain has become increasingly complicated. Some stakeholders claim that fostering collective security may coincide with a reconceptualized notion of social responsibility (Causevic et al., 2022).

Understanding the defense industry from an investment perspective is essential given today's geopolitical instability and the inherent characteristics of these securities, which are often regarded as a means of risk management and diversification during periods of uncertainty.

The US Defense industry revolution, also known as the “Military Industrial Complex” (referred to as such by the US President, Dwight D. Eisenhower), commenced during World War II and underwent a substantial transformation through the Cold War era, continuing to evolve rapidly into the present day, its military superiority is predominantly attributed to the primacy of American arms producers in fulfilling national security imperatives over economic interests. The predominant influence on arms production and sales is domestic military demand, which serves as the primary driver (Blum, 2019).

Defense contractors operate within a highly concentrated customer environment, primarily dealing with governmental entities such as the White House, Congress, the Department of Defense (DoD), military commanders, and NATO agencies, making defense companies' revenues heavily dependent on long-term government contracts. For instance, the budget of the Department of Defense (DoD) has exceeded $900 billion on an annual basis towards supporting research and development (R&D), procurement of new systems, and maintenance and operation of existing capabilities (Sacknoff, 2023). Additionally, the Buy American Act mandates that the final product must be mined, produced, or manufactured in

the United States, and if manufactured, at least 50% of the costs of its components must be sourced domestically or the product must be a commercially available off-the-shelf item (Buying American: The Berry and Kissell Amendments, 2025).

In the context of escalating geopolitical risk, the strategic role of the defense industry seems to be relevant. Historically, the practice of arms manufacturing has been regarded by numerous sustainability-focused investment funds as non-ESG-compliant or even socially controversial (Causevic et al., 2022). However, the geopolitical uncertainty following the outbreak of war in Ukraine has revealed a countervailing perspective. It has been argued that modern equipment is not only necessary for the protection of national borders but also for fostering the stability essential for sustainable development (Dimitrova et al., 2021). Consequently, investor sentiment toward defense firms in certain markets has exhibited signs of moderation, with commentators increasingly contending that an effective deterrent serves as a cornerstone for broader ESG objectives by establishing a secure environment conducive to the proliferation of climate and social initiatives. Amid these tensions, several banks and investment funds are recalibrating their policies. For instance, SEB Investment Management, a Swedish financial institution, recently relaxed its self-imposed prohibition on financing companies deriving more than 5% of revenue from defense activities, citing "rising geopolitical tensions" following the invasion (Singh et al., 2022). This context prompts the inquiry of whether defense companies, particularly those headquartered in the U.S. with established technology and stable government contracts, can demonstrate superior risk-adjusted performance in comparison to more conventional or environmentally responsible portfolios.

This interdependence underscores the symmetrical relationship between the financial viability and stock performance of the industry and the dynamics of defense budgets and geopolitical contexts. Consequently, the industry demonstrates a high degree of sensitivity to political and economic shifts (Berteau et al.). According to the Association of Defense Manufacturers (AIA), the A&D industry alone generated a total business output of $955 billion in 2023 (AIA, 2024). A substantial surge in U.S. arms exports, amounting to a 17% increase, signifies the resilience of American defense contractors in the face of global turbulence. Furthermore, the Department of Defense has allocated a security assistance budget of over $65.4 billion to Ukraine since the onset of the invasion on February 24th, 2022. (U.S. Department of Defense, 2024).

Therefore, the United States' defense industry offers investors a distinct portfolio of financial returns, bolstered by a reliable demand from the government and resilience in the

face of geopolitical turbulence. The resulting shift in global capital flows exemplifies a significant recalibration, indicating that it has become increasingly challenging for institutional investors to maintain a comprehensive exclusion of defense contractors. This has opened the way for a more profound examination of the performance of these assets under persistent geopolitical tensions (Blum, 2019). To address such issues thoroughly, it is necessary to quantify whether, and by how much, defense-related equities deliver superior returns relative to their risk, as well as how they fare against broader benchmarks.

The methodology section describes the empirical approach in question in detail. The Sharpe ratio is utilized to assess the risk-adjusted returns of investments in U.S. defense companies. The accuracy of the Sharpe ratio in evaluating portfolio performance within volatile, high-risk environmental conditions typically observed during geopolitical crises is well-founded. A comprehensive discussion is provided on benchmarking strategies, with particular emphasis on the rationale behind selecting comparative benchmarks such as the MSCI USA Equal Weighted and the SPADE DEFENSE Indexes. These comparisons enable the isolation of the specific performance characteristics of defense-related subsectors relative to a broader market. The selection criteria for the subsectors in which the companies are classified and the indexes used as benchmarks are further explained in the Data Overview section. The data sources employed in this study include FactSet and Refinitiv Eikon, from which the key statistics are derived.

In the empirical analysis and results section, we present computed Sharpe ratios alongside basic return statistics for defense investments and Skewness and Kurtosis levels, clearly contrasted against our selected benchmarks. We identify key patterns and performance trends within the data, particularly noting periods where defense-related investments demonstrate notably superior or inferior performance relative to general investments.

The reasons for using the Sharpe ratio are made even clearer when looking at the current global macroeconomic and political situation. Geopolitical events, such as the Russia–Ukraine war and renewed instability in the Middle East, have significantly elevated market risk and cross-asset volatility (Singh et al., 2022). In such contexts, conventional return-based metrics may misrepresent the true investment performance of sectors such as defense, which are particularly sensitive to shifts in government policy, international conflict, and defense spending cycles. The US government is the primary client of most of the US Defense firms (Sacknoff, 2023). From a pragmatic standpoint, the Sharpe Ratio serves as a practical instrument for evaluating performance, as well as for capital allocation

and risk signaling. In periods of increased geopolitical tension, investors may seek to allocate capital into defense stocks, perceiving them as a form of "crisis hedging", which can lead to amplified returns and heightened volatility.

The final section of this study interprets empirical findings in the context of the reviewed literature. We assess whether our results confirm the hypothesis that defense stocks act as safe-haven assets during times of heightened geopolitical uncertainty, and which subsector does so. The findings of this study will indicate whether the defense sector provides compelling risk-adjusted returns amid rising global tensions. In addition, we put forward several research directions for future exploration. These include the potential investigation of factor models, international comparative analyses, Markowitz and Black-Litterman model implementation, and behavioral finance experiments. These additional studies could validate and expand upon our current findings.

As noted, most existing literature examines the relationship between geopolitical conflicts and the performance of defense stocks from a broad, aggregate perspective, most of them considering multiple regions or global defense indices. However, research focused specifically on the U.S. defense industry is limited. Even within U.S.-focused studies, the emphasis tends to be on general stock returns, failing to examine how geopolitical tensions influence the sector's risk-return profile. Significantly, there is a notable absence of research on how such conflicts affect different subsegments of the U.S. defense industry, including manufacturing and cybersecurity systems. To date, no comprehensive academic study has disaggregated the sector to assess the differential impact across these subindustries or benchmarked these findings against a broader index and the potential new investment opportunities available to investors. To the best of our knowledge, no literature covers the variations of in risk-return relationships of U.S. aerospace and Defense stocks across recent geopolitical conflicts.

In this regard, our study extends this line of research to determine which subsectors of the U.S. Aerospace & Defense industry (A&D), such as manufacturing, unmanned systems, cybersecurity, advanced munitions, and electronic warfare, are deriving the greatest risks-adjusted benefits from the evolving nature of modern warfare and whether its ability to outperform standard benchmarks in volatile contexts, it is plausible that institutional investors will sustain or even expand their allocations to these industries, extending their commitment long after the immediate crisis has subsided. This emphasis on subsector-level performance is consistent with a broader inquiry into whether the U.S. defense sector, in its entirety, attains superior risk-adjusted returns when measured using benchmarks such as the

Sharpe ratio, in periods of heightened geopolitical tension. While the Russia–Ukraine war and the Israel–Hamas conflict are immediate catalysts, the findings of this study have broader implications. Specifically, the findings can help anticipate how potential future conflicts or escalations of current ones might affect the attractiveness of the U.S. defense industry to investors, particularly concerning risk-adjusted returns and capital allocation strategies. In other lines, it can also help us analyze the relevance of portfolio optimization even within an industry.

I. LITERATURE REVIEW

Defense stocks have been shown to serve as effective hedges against geopolitical risks, typically outperforming the market during periods of conflict or heightened international tensions. The US defense sector has demonstrated a consistent ability to outperform the market while offering dividends to investors. Investors who purchased at the market's peak would have recuperated their investment by reinvesting dividends within a three-year time frame (Sacknoff, 2023). Regarding war conflicts, those tend to cause improvements in share price performance (Saphiro et al., 2011). Moreover, Gurdgiev et al. (2022) conclude that Defense stocks provide investors with a quick but short-lived hedge when the U.S. enters a direct conflict, but indirect conflicts generate significant and lagged positive abnormal returns.

According to Feng et al. (2023), an increase in geopolitical risk prompts a "flight-to-safety" dynamic, particularly favoring U.S.-based assets. Their comprehensive panel analysis, encompassing 45 economies, reveals a pronounced correlation between escalating geopolitical risk and the augmentation of foreign direct investment into advanced economies, such as the United States, concurrent with a contraction in capital outflows from emerging markets. Gupta et al. (2019) also demonstrate that geopolitical risk has a deleterious effect on global trade, prompting investors to rotate capital away from fragile and trade-dependent regions toward core geopolitical actors like the U.S. coinciding with Yousaf et al. (2022) findings where he noted and increase in the US stocks on the event day. The recalibration of investor behavior in response to the Russia–Ukraine war is further highlighted by Singh et al. (2022), who conclude that defense equities, particularly those included in aerospace and defense indices, gained renewed legitimacy and strategic value in the eyes of global investors. Their empirical findings indicate that investors increasingly view the defense sector as a critical pillar of geopolitical and economic stability, prompting capital inflows that were previously directed toward ESG-aligned sectors.

Federle et al. (2024) introduce further nuance by demonstrating that during the initial phases of the Russia–Ukraine conflict, defense companies situated in closer proximity to the war zone exhibited significantly lower performance in comparison to the market. Their study found that defense sector equities exhibited abnormal returns reaching up to 60%, with the premium increasing by 4.7 percentage points per 1,000 kilometers of distance from Ukraine, which underscores the strategic appeal of the US economy in regards if this conflict. Conversely, Boubaker et al. (2022) study suggests a positive impact on NATO member

nations during the post-event period, consistent with expectations regarding the economic stimulus derived from heightened military preparedness. Complementary, Silva et al. (2023) employ an event-study approach to demonstrate that defense equities in NATO countries experienced significant abnormal positive returns following the outbreak of war in Ukraine. Their findings underscore the pivotal role of policy responses, particularly the augmentation of defense budgets, in fostering investor confidence. Yilmazkuday, H. (2024) employed a local projections methodology across 29 countries and found that positive shocks to the Geopolitical Risk (GPR) Index significantly depress equity valuations in most economies, with particularly strong effects in the Eurozone, the United States, and China. In a similar vein, Gheorghe and Panazan (2024) identify a robust positive relationship between the GPR Index and defense firm excess returns, particularly among global defense firms. Moreover, several empirical studies have demonstrated a positive correlation between geopolitical risk (GPR) and asset price volatility, particularly within sectors that are directly linked to national security and defense. Zhang et al. (2022) employed wavelet coherence analysis to demonstrate that defense and aerospace equities exhibit increased variance and robust positive co-movements with the GPR Index over medium- and long-term investment horizons, particularly in the United States and Europe. This phenomenon, termed "flight-to-arms," is analogous to the more well-known "flight-to-safety" behavior. It suggests that defense equities are perceived by investors as protective assets during times of geopolitical instability. Additionally, Liang's (2024) study demonstrates how an increase in war-related media attention leads to an escalation in the volatility of defense stocks, concurrently enhancing the precision of volatility forecasts. This phenomenon renders defense stocks more predictable and appealing within risk-managed investment strategies. Klein (2024) further explores the microstructure of these reactions using intraday data. His findings reveal that news shocks related to geopolitical crises trigger significant increases in realized volatility among defense equities, particularly when those shocks are unexpected. Furthermore, the study underscores the pivotal role of investor sentiment and behavioral shifts in amplifying such volatility, emphasizing that these effects persist across multiple time horizons. Similarly, Azimli & Kalmaz (2025) demonstrate that geopolitical tensions significantly amplify higher-moment risk characteristics (skewness and kurtosis) in defense equity returns. However, these stocks simultaneously offer superior performance, reinforcing their utility as high-risk, high-reward instruments during uncertainty.

However, Essaddam (2013) determined that defense firms don’t behave equally as they depend on the percentage of their sales that go into the arms industry concurring with

Klomp's (2024) findings, derived from a comprehensive panel, reveal a pronounced correlation between the imposition of arms embargoes and a substantial decline in corporate revenues, particularly within jurisdictions characterized by robust institutional enforcement mechanisms. These findings underscore the dual-edged nature of geopolitical conflict, as it can boost demand for defense products and introduce compliance and political risks that can adversely affect firm performance and valuation.

Furthermore, Deng (2021) demonstrates that during the 2017 and 2020 China-India border conflicts, defense sector portfolios with high Sharpe Ratios exhibited consistent outperformance in comparison to both market indices and ethical investment portfolios. These findings lend support to the hypothesis that the Sharpe Ratio is a suitable metric in conflict-driven, high-uncertainty environments. Consequently, an increasing Sharpe ratio during periods of conflict may be indicative of a combination of institutional repositioning, anticipated increases in government spending, and revived investor risk appetite (Jarlén & Jönsson, 2015). Despite these two studies, the Sharpe Ratio analysis in the US Aerospace and Defense Industry remains limited.

Despite its reputation as a resilient industry, there are some risks when allocating capital to this sector. For example, one characteristic of the defense sector, as described earlier, is its correlation with government budgets. As Blum (2019) observes, the correlation between arms sales and defense spending is significant; a 1% change in defense spending can result in a disproportionate change in revenues for defense companies. Furthermore, these entities are subject to the International Traffic in Arms Regulations (ITAR), and to become ITAR compliant, there is a bureaucratic process that can be time-consuming and uncertain, a fact that is not generally acknowledged by investors. As Peng (2017) emphasizes, even promising startups with innovative technology may encounter challenges in navigating the protracted and uncertain procurement timelines, potentially leading to a reduction in potential investment returns.

At this point, the collective evidence from these studies demonstrates that Aerospace and Defense sector (A&D) equities exhibit a positive response to geopolitical shocks and offer investors a distinct asset class. Nevertheless, the existing literature is limited to either the effects of past geopolitical conflicts on the overall returns of the defense industry, to the changes in its volatility, showing a shortage of research on risk-adjusted returns of defense subsectors given the current shifts the battlefield is experiencing and, more specifically, in the U.S., as it represents the main source of arms globally. Additionally, there is a notable gap in the literature regarding the financial market implications of more recent and ongoing

conflicts, such as the 2023 Israel–Hamas war. Despite its geopolitical relevance, this conflict has received minimal academic attention regarding its impact on defense-related stocks and investor behavior. Therefore, in this study, we will answer how recent wars and geopolitical conflicts, including the Israel–Hamas attacks, have shaped and affected the risk-return relationship of each A&D subsector, catching the eye of investors looking to optimize their portfolios during times of geopolitical instability.

II. METHODOLOGY

The present study has been conducted to evaluate the risk-return profile of the U.S. Aerospace & Defense Industry (A&D) subsectors during heightened geopolitical uncertainty, especially driven by the Ukraine invasion and the Middle East Conflict between 2022 and 2024. Our sample period is divided into 3 stages: a) "Pre–War", which goes from January 2021 to February 22nd of 2022; b) "Ukraine War", spanning from February 23rd of 2022 (one day prior the Official Russian invasion) until October 6th of 2023; c) "Israel Conflict" from October 6th of 2023 to December 31st of 2024. It is important to note that the Ukraine–Russia conflict began in 2014 with the annexation of Crimea. However, we are considering this period since it is when it gained more global attention. To this end, the study derives its data from three primary sources: SPADE Indexes, FactSet, and Refinitiv Eikon. The SPADE Defense Index is a recognized benchmark for the U.S. Aerospace & Defense sector that provides a comprehensive list of firms classified within various defense subsectors, such as aerospace, electronics, cybersecurity, and other related industries. The dataset encompasses daily end-of-day values and key financial statistics spanning the preceding four years, encompassing both pre- and post-periods relative to the escalation of geopolitical tensions following Russia's invasion of Ukraine in February 2022 and the Israel-Hamas conflict outbreak in October 2023. Furthermore, the MSCI USA Equal Weighted Index (MSCI, 2025) is employed as a comparative broader market benchmark to contextualize the performance of defense subsectors against the global U.S. equity market, due to being more diversified than the S&P500 (over 600 companies vs 500) and includes both large and mid-caps while the S&P500 is purely based on large caps.

To this end, the study employs the Sharpe Ratio as the principal analytical tool. This approach captures not only the absolute returns of each subsector but also the volatility incurred in generating those returns, thus offering a more comprehensive picture of the A&D investment efficiency compared to a broader picture. Both the subsectors and the index used as a benchmark will be further explained in the sections below.

In the field of financial research and portfolio optimization, the Sharpe Ratio is commonly regarded as a primary metric for performance evaluation, particularly in cases where portfolios may not be mean-variance efficient. As demonstrated by Kourtis (2016), Sharpe Ratios penalize portfolios whose returns are driven by extreme tail risks or estimation errors, thereby favoring stable and risk-adjusted outperformers. In the context of this study, the Sharpe Ratio is applied to subsectors within the SPADE Defense Index, including but not limited to cybersecurity, aerospace platforms, and systems engineering, to identify which

segments outperform after adjusting for volatility. These subsectors are further described in the Data Overview Section.

Before we go into the Sharpe Ratio, the first step we carry out is reviewing the risk-return tradeoff, as it is fundamental to measuring profitability and optimal allocation of securities when building a portfolio. To measure the risk of an asset, in this case, a subsector of the U.S A&D Industry, we will use the volatility of the assets as a proxy of risk, which is calculated through their standard deviation. It represents the variability of asset returns over a period. For this study, we will be using the standard deviation from the daily returns of the SPADE Defense Index constituents grouped by subsector.

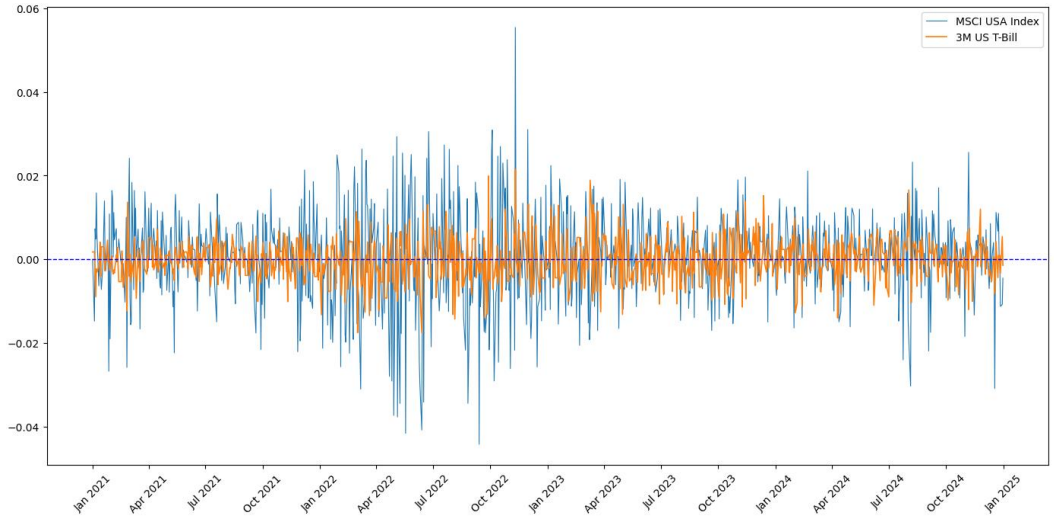
To calculate the Sharpe ratio and evaluate the risk-adjusted performance of the subsectors, we need to define a reliable estimate of the risk-free rate of return. This rate shows the theoretical return of an investment with no credit risk and low volatility, which is usually associated with short-term government securities. As Damodaran (2008) states, a truly risk-free instrument must satisfy two key conditions: (1) it must be free from credit risk, meaning that the issuer (typically a government) will not default on its obligations; and (2) it must eliminate reinvestment risk over the relevant investment horizon. The only zero-coupon government securities that meet this definition are those with a duration that matches the investment period. However, in practical applications and academic finance, this requirement is often relaxed in favor of easier-to-use alternatives (Damodaran, 2008). The 3-month U.S. Treasury Bill is considered to be the global risk-free rate (Sarno, 2002). Nevertheless, since 2019, the US risk-free rate has experienced significant volatility, largely driven by monetary policy interventions in response to macroeconomic shocks, especially COVID-19. Due to this volatility, a static risk-free rate assumption would introduce distortions in the Sharpe ratio and misstate excess returns. Therefore, this study considers the inclusion of a time-varying daily series of the 3-month US Treasury Bill yield, sourced from FactSet.

While the T-Bill is commonly used as a proxy for the risk-free rate due to its negligible credit risk and minimal volatility, some studies suggest evaluating alternative benchmarks, especially in contexts where returns from equities or equity-like instruments are used in portfolio modeling. For instance, Kreander et al. (2005) argues that in certain macroeconomic environments, equity market benchmarks may absorb characteristics of perceived "safety" due to persistent liquidity premiums. Given the focus on US-based stocks, a comprehensive index that encompasses firms from all sectors was considered the most suitable option. Following Kreander's et al. (2005) assumptions, the MSCI USA Index is

selected to be analyzed as an alternative for the 3-month U.S. Treasury Bill as a risk-free reference. This decision was made to ensure the integrity of the risk-free rate since the MSCI USA Index encompasses over 600 U.S. companies, excluding those with a low market capitalization, mitigating the index's overall risk exposure. We first considered using the MSCI USA Equal Weighted index, but since it is the one being used as a benchmark, it would be counterintuitive to also use it as a risk-free measure.

Therefore, we first compare the daily log returns of the 3-Month Treasury Bill and, MSCI USA Index, calculated based on their daily prices from 2021 to 2024, to see which one will be used. Additionally, we will conduct a brief volatility analysis using their standard deviation.

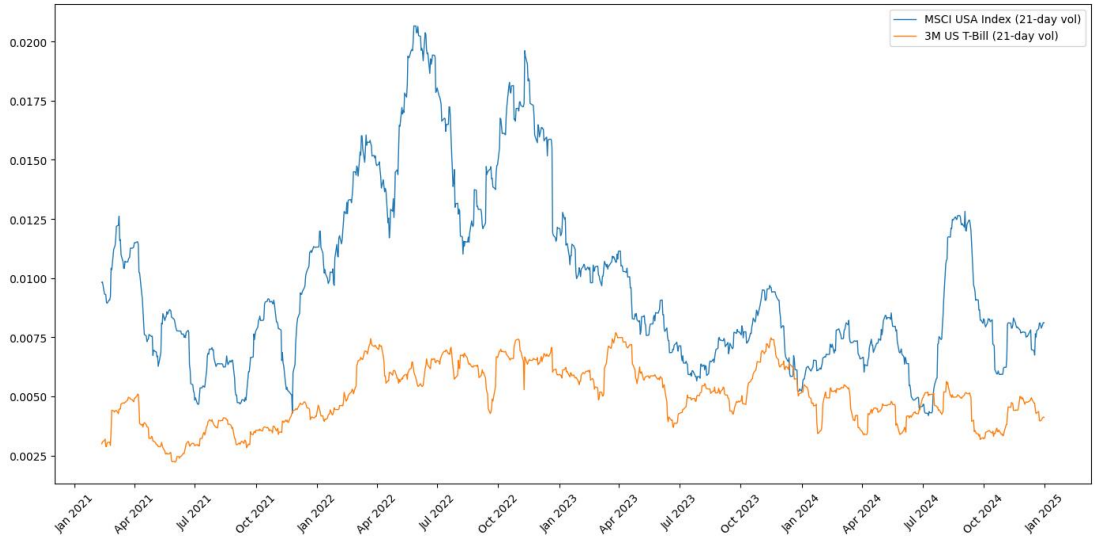
Figure 1 – *Daily Log Returns per month of risk-free assets (2021-2024)*



Source: Own Elaboration using data from FactSet

As demonstrated in Figure 1, the 3-month U.S. Treasury Bill (orange line) exhibits the most stable and near-zero daily returns across the entire sample period. This observation aligns with its low-risk profile, which is characterized by its predictability. In contrast, the MSCI USA Index (blue line) displays more pronounced fluctuations, with both positive and negative spikes, which are typical of equity market movements.

Figure 2 – *Rolling Standard Deviation of risk-free assets log returns (2021-2024)*



Source: Own elaboration using data from FactSet

Moving on to the variability of these assets during the respective period, Figure 2 confirms what is shown on the previous chart. The three-month U.S. Treasury Bill demonstrates the lowest and most stable variability, confirming its theoretical designation as a risk-free asset. In contrast, the MSCI USA Index (blue line) shows elevated volatility, reflecting, despite its broad diversification, the inherent market risk and equity price fluctuations, especially at the beginning of the Ukraine War.

In summary, the 3-month U.S. Treasury Bill has been demonstrated to exhibit superior stability in comparison with the other alternatives. This finding supports the selection of the U.S. 3-M T. Bill as the appropriate risk-free rate for Sharpe Ratio calculations in the present study. It is important to say that the previous charts don't serve as comparable data for the U.S. Defense subsectors

After we selected the risk-free asset, to assess the daily performance of the defense-related subsectors and benchmark index, we began by computing their daily returns based on the closing prices of each subsector firm constituent, retrieved from the FactSet database. From these individual observations, we derive the average daily return for each asset. We will adopt the logarithmic return as it allows us to use the continuously compounded returns (Schopohl, 2019). Due to the absence of daily market capitalization data for each firm, subsector performance is measured by an equal-weight average of constituent daily log returns. Although a cap-weighted approach is standard for investable indices, equal-

weighting is more appropriate here because the goal of the study is a comparative analysis of risk-return characteristics across subsectors, not portfolio construction. On each trading day *t:*

$$R_{s,t} = \frac{1}{N_s} \sum_{i \in s} ln \frac{P_{i,t}}{P_{i,t-1}}$$

Where:

- N_s denotes the number of firms in subsector/index *s*
- $P_{i,t}$ denotes the stock price *i* at time *t*
- ln denotes the natural logarithm

It is also a time-additive, meaning that returns over multiple periods can be added together. These properties make it particularly useful for analyzing the Defense stock's financial performance.

From the daily log returns of each subsector, the standard deviation of the dataset was calculated.

With the daily statistics obtained, we finally proceed to calculate the Sharpe Ratio, as proposed by Sharpe (1994), which quantifies the excess return per unit of risk. It facilitates the comparison of sectors with differing volatilities on equal footing (Sharpe, 1994), which is essential in the case of defense equities given their exposure to both cyclical and geopolitical shocks. To assess performance, the Sharpe Ratio of each defense subsector is compared with that of the MSCI USA Equal Weighted Index over the same period (2021–2024). A positive Sharpe Ratio spread relative to the MSCI benchmark is interpreted as evidence of risk-efficient outperformance.

The term is defined as follows:

$$SharpeRatio = \frac{R_s - Rf}{\sigma_s}$$

Where:

- R_s denotes the log return of subsector/index *s*
- R_f denotes the risk-free rate (proxied by the 3-month U.S. Treasury Bill)

- σ_s denotes the standard deviation of daily log returns of subsector/index *s*

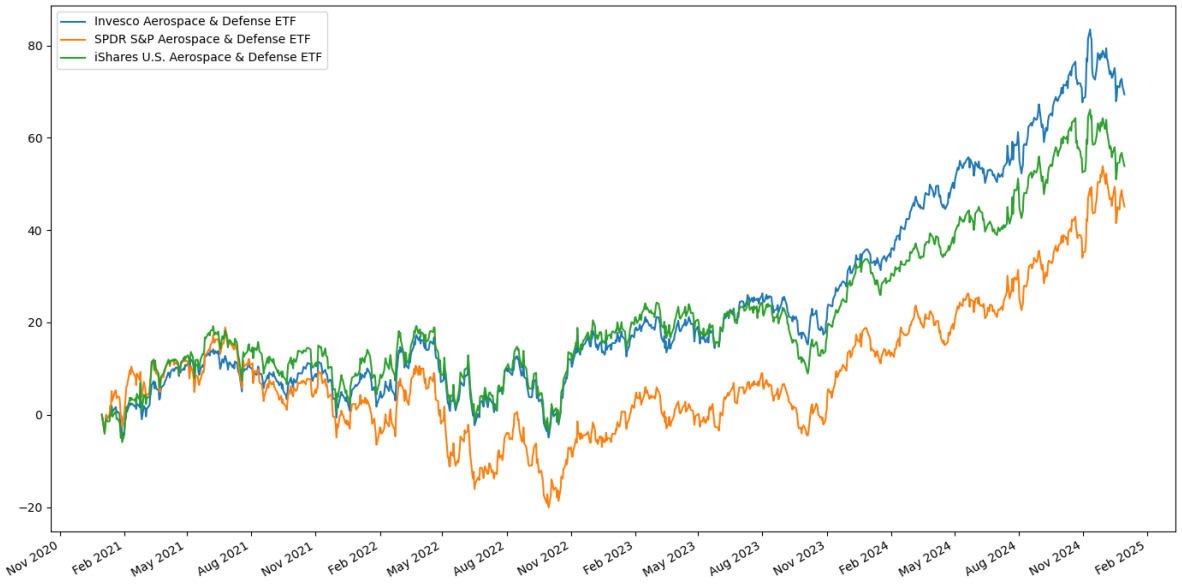
  For the Sharpe Ratio, the daily logarithmic returns and their respective standard deviations collected in the previous steps are used. Since the risk-free rate is annualized, we converted to daily for ease of calculation and then annualized the Sharpe Ratio to have values per period and subsector/index.

III. DATA OVERVIEW

Defense ETFs (Exchange Traded Funds) constitute a compelling investment vehicle for more risk-averse investors. There are 3 main ETFs, all of which focus on the defense sector, but have notable disparities. First, iShares U.S. Aerospace & Defense ETF (ITA) replicates The Dow Jones U.S. Select Aerospace & Defense Index which tracks the performance of leading American aerospace and defense companies based on a weighted market cap methodology (iShares by BlackRock, 2025). Additionally, ITA's primary holding accounts for approximately 20% of its total weight. Secondly, there is the SPDR® S&P® Aerospace & Defense ETF (XAR), which replicates the S&P Aerospace & Defense Select Industry Index (S*PDR® S&P® Aerospace & Defense ETF*, 2025), and it is distinguished by its status as the sole fund that equals its holdings. This approach suggests that a tier-three supplier would have the same rebalancing weight as a prime contractor, such as RTX or Lockheed Martin, giving more exposure to mid and small caps. The benchmark index focuses on manufacturers, assemblers, and distributors of aircraft and aircraft components, as well as producers of components and equipment for the defense industry. This includes military aircraft, radar equipment, and weapons (S*PDR® S&P® Aerospace & Defense ETF*, 2025). In contrast, The Invesco Aerospace & Defense ETF (PPA) (Invesco, 2025) replicates the SPADE Defense Index, which we extracted our sample from and is further explained in the next section, it is noteworthy for its systematic inclusion of all firms considered relevant to the Pentagon and US National Security (currently holds over 50 US A&D firms), and its TrueCap weighting methodology (Sacknoff, 2023).

According to Figure 3 that shows the price evolution since November 2020, right after COVID-19 hit, we can see that both ETFs have had very similar performance… until the end of 2022 after the Ukraine war started and investors started to take into account the relevance of IT, remote control devices and C4ISR in general, a subsector that has an increasing weight in the SPADE Defense Index.

Figure 3 - *Defense ETFs Performance Comparison (%)*



Source: Own elaboration using data from FactSet Database

When determining the subsectors we are analyzing, we have followed the SPADE Defense Index criteria and, as we consider to be the most accurate US Defense Index, with more data available. The index covers all aspects of the sector, including infrastructure, services, IT and cyber activities, and support. This index is calculated using a modified market capitalization weighting methodology (TrueCap) that accurately reflects the weightings assigned to highly diversified firms (i.e., Lockheed Martin or General Electric) by focusing on the relevant business activity within a sector/theme (i.e., defense, aerospace, homeland security, space) as if it were a standalone entity. This way, these firms can be measured according to a particular market segment where they operate, eliminating disparities between the big, highly diversified, and the more niche firms (i.e., Kratos Defense).

Additionally, to follow the Index accuracy in this study, the components are grouped in four subsectors according to SPADE Indexes LLC criteria:

i) Prime System Contractors: Companies that are awarded a contract or program that requires a significant amount of funding. For example, Lockheed Martin is the prime contractor for the F-35 fighter jet, meaning it oversees the development of the jet and its subcontractors. Since the Cold War, the major prime contractors have been Lockheed Martin (LMT), Northrop Grumman (NOC), Raytheon Technologies (RTX), Boeing (BA), and General Dynamics (GD). They are referred to as the "Big Five" (*The U.S. Defense Industrial Base: Background and Issues for Congress*,

2025).

ii) Manufacturing Systems, subsystems, components, and hardware: Companies that focus on building the parts for a program or contract. They are usually referred to as subcontractors. As seen in Table 1, it is the subsector with the most exposure.

iii) Services and Support: Specializes in providing support to the military during operations.

iv) Technology/C4ISR: Companies that integrate command, control, communications, computers, intelligence, surveillance, and reconnaissance systems into the military and the battlefield. It has recently been on the watch list of many investors due to its strong link with AI and machine learning, as well as developments in the Ukrainian War.

As reported in Figure 6, the Big Five have been the worst-performing subsector since COVID, as investor preference is shifting towards smaller companies, often niche ones that offer a more attractive risk/return ratio. This point is further developed in Section Results.

Consequently, Table 1 shows an overview of the firms and subsector constituents for this sample, their closing price, and market capitalization as of December 31st, 2024. Because of the Index changes in size and composition, we kept the same firms as in the last Index report. The predominant sector in terms of the number of firms is the Manufacturing Systems, subsystems, components, and hardware; nevertheless, the biggest in terms of market capitalization per firm is the Prime System Contractors. It gives a picture of how structured each subsector is and how difficult it is for companies to get in.

Table 1
Overview of the company selection and subsectors. Data is obtained from Refinitiv Eikon with the corresponding ticker (data as of December 31st, 2024)

#	Company	Ticker	Subsector	Price	Market Cap ($Bn.)
1	AAR	AIR	Manufacturing: Systems, Subsystems, Components, and Hardware	61.28	2.21
2	AeroVironment	AVAV	Manufacturing: Systems, Subsystems, Components, and Hardware	153.89	4.34
3	Amentum	AMTM	Services and Support	21.03	5.12
4	Amphenol	APH	Manufacturing: Systems, Subsystems, Components, and Hardware	69.45	84.01
5	ATI	ATI	Manufacturing: Systems, Subsystems, Components, and Hardware	55.04	7.76
6	AXON International Inc.	AXON	Manufacturing: Systems, Subsystems, Components, and Hardware	594.32	46.27
7	Barnes	B	Manufacturing: Systems, Subsystems, Components, and Hardware	47.26	2.42
8	Boeing	BA	Prime System Contractors	177.00	133.46
9	Booz Allen	BAH	Services and Support	128.70	16.30
10	BWX Technologies	BWXT	Manufacturing: Systems, Subsystems, Components, and Hardware	111.39	10.18
11	C3.ai	AI	Technology/C4ISR	34.43	4.57
12	CACI Intl	CACI	Technology/C4ISR	404.06	8.89
13	Cadre Holdings	CDRE	Services and Support	32.30	1.31
14	CAE	CAE	Manufacturing: Systems, Subsystems, Components, and Hardware	25.38	8.11
15	Curtiss Wright	CW	Manufacturing: Systems, Subsystems, Components, and Hardware	354.87	13.38
16	Ducommun	DCO	Manufacturing: Systems, Subsystems, Components, and Hardware	63.66	0.95
17	Eaton	ETN	Manufacturing: Systems, Subsystems, Components, and Hardware	331.87	130.02
18	Elbit Systems	ESLT	Manufacturing: Systems, Subsystems, Components, and Hardware	258.07	11.52
19	General Dynamics	GD	Prime System Contractors	263.49	70.72
20	General Electric	GE	Manufacturing: Systems, Subsystems, Components, and Hardware	166.79	177.86
21	Heico	HEI	Manufacturing: Systems, Subsystems, Components, and Hardware	237.74	33.03
22	Hexcel	HXL	Manufacturing: Systems, Subsystems, Components, and Hardware	62.70	5.04
23	Honeywell	HON	Manufacturing: Systems, Subsystems, Components, and Hardware	225.89	145.18
24	Howmet	HWM	Manufacturing: Systems, Subsystems, Components, and Hardware	109.37	44.24
25	Huntington Ingalls	HII	Manufacturing: Systems, Subsystems, Components, and Hardware	188.97	7.41
26	Iridium	IRDM	Technology/C4ISR	29.02	3.14
27	Jacobs Engineering	J	Services and Support	133.62	16.37
28	KBR	KBR	Services and Support	57.93	7.52
29	Keysight	KEYS	Technology/C4ISR	160.63	27.76
30	Kratos Defense & Security	KTOS	Manufacturing: Systems, Subsystems, Components, and Hardware	26.38	4.04
31	L3 Harris	LHX	Manufacturing: Systems, Subsystems, Components, and Hardware	210.28	39.31
32	Leidos	LDOS	Technology/C4ISR	144.06	18.47
33	Leonardo DRS	DRS	Manufacturing: Systems, Subsystems, Components, and Hardware	32.31	8.60
34	LOAR	LOAR	Manufacturing: Systems, Subsystems, Components, and Hardware	73.91	6.91
35	Lockheed Martin	LMT	Prime System Contractors	485.94	113.85
36	Mercury Computer Sys	MRCY	Manufacturing: Systems, Subsystems, Components, and Hardware	42.00	2.51
37	Moog Inc.	MOG.A	Manufacturing: Systems, Subsystems, Components, and Hardware	196.84	6.21
38	Northrop Grumman	NOC	Prime System Contractors	469.29	67.54
39	Oshkosh	OSK	Manufacturing: Systems, Subsystems, Components, and Hardware	95.07	6.14
40	OSI Systems	OSIS	Manufacturing: Systems, Subsystems, Components, and Hardware	167.43	2.81
41	Palantir	PLTR	Technology/C4ISR	75.63	178.46
42	Parker Hannifan	PH	Manufacturing: Systems, Subsystems, Components, and Hardware	636.03	81.90
43	Parsons	PSN	Technology/C4ISR	92.25	9.85
44	Raytheon Technologies	RTX	Prime System Contractors	115.72	154.60
45	Rocketlab	RKLB	Manufacturing: Systems, Subsystems, Components, and Hardware	25.47	11.55
46	SAIC	SAIC	Technology/C4ISR	111.78	5.27
47	Spirit	SPR	Manufacturing: Systems, Subsystems, Components, and Hardware	34.08	4.00
48	Teledyne	TDY	Manufacturing: Systems, Subsystems, Components, and Hardware	464.13	21.75
49	Textron	TXT	Manufacturing: Systems, Subsystems, Components, and Hardware	76.49	13.81
50	Transdigm	TDG	Manufacturing: Systems, Subsystems, Components, and Hardware	1267.28	71.07
51	Triumph	TGI	Manufacturing: Systems, Subsystems, Components, and Hardware	18.66	1.44
52	TTM	TTMI	Manufacturing: Systems, Subsystems, Components, and Hardware	24.75	2.52
53	V2X	VVX	Manufacturing: Systems, Subsystems, Components, and Hardware	47.83	1.51
54	Viasat	VSAT	Manufacturing: Systems, Subsystems, Components, and Hardware	8.51	1.10
55	Woodward	WWD	Manufacturing: Systems, Subsystems, Components, and Hardware	166.42	9.88

Source:OwnElaboration using data from FactSet

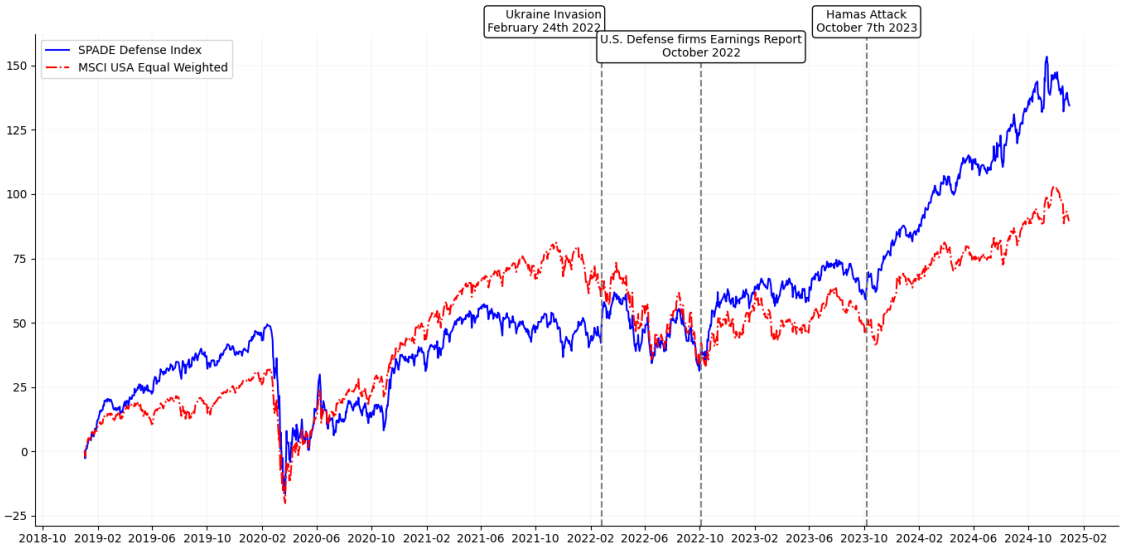
Our sample period runs from January 2nd, 2021, to December 31st, 2024, covering the outbreaks in Ukraine and Israel. In this way, we ignore the COVID-19 effects but still have data from before the conflict outbreak under study. Although these are active conflicts, for the study, we chose to segment the Ukrainian conflict from February 22nd, 2022, to October 6th, 2023, just before the Hamas terrorist attack. This allowed us to isolate and better

analyze the effects of each conflict separately while keeping the influence of the named conflict. In addition, we follow the suggestion of Mackinlay (1997) to use an event window of more than 120 days.

We gather daily data for each company that takes part in the SPADE Defense Index Aerospace & Defense subsector according to its Index Last Report ("SPADE Investor" Newsletter - the Spade Indexes, 2025). Afterwards, we transform the daily returns into log-returns, plotted in Appendix Figure a1, where we can see big fluctuations, especially during the war period (without taking into consideration those from COVID time). We can already see that one of the most volatile subsectors is Technology/C4ISR, with companies such as Palantir (PLTR) or Keysight (KEYS), compared to some of the prime contractors such as Boeing or General Electric, whose returns have been more stable.

In the four years leading up to Russia's invasion, the defense sector looked almost "dormant" to the outside world, even though significant budgets were already in place. Global military spending had plateaued at just under $2 trillion, and the US government was operating in maintenance rather than procurement mode. In the US, still the anchor customer sector, the Pentagon's revenue growth after FY2018 averaged barely 2% in real terms, and primes such as Lockheed Martin or RTX were harvesting long-cycle programs rather than booking blockbuster new orders (Sacknoff, 2023). Europe, for its part, was still living off the so-called "peace dividend"; arms imports between NATO states fell in 2014-18 and only began to rise modestly in 2019 (Wezeman et al., 2025). Capital market sentiment reflected this lethargy. Defense stocks were persistently underweighted in ESG and factor portfolios. Additionally, as reported in Figure 4, the Defense industry, during the period mid-2020-2021, recovered from the COVID hit while the rest of the markets managed to achieve all-time Highs. In other words, the US Defense Industry was lagging.

Figure 4 - *Index Price Movements (2019-2024)*



Source: Own elaboration using data from FactSet.

As Russia invaded Ukraine in February 2022, the global geopolitical landscape underwent profound transformations. According to the Stockholm International Peace Research Institute (SIPRI), European arms imports increased by 155% between the periods 2020–2024, with Ukraine emerging as the fourth largest arms importer globally due to urgent military needs during the conflict (Wezeman et al., 2025). Concurrently, the United States augmented its arms exports by 21% over the same period, thereby reinforcing its status as the world's leading defense exporter. This surge in exports was accompanied by a substantial increase in U.S. defense budgets, with the fiscal year 2023 allocation reaching $813.3 billion (Schumann, 2022), a figure that underscores the structural rise in military spending among NATO allies. As reported in Figure 4, the outbreak of the War marked the start of a record-high volatility period until the Earnings Report in October 2022, which caused a shift towards record highs.

Quite after, Hamas declared war on Israel, a historical US ally. Consequently, the American country started sending arms to its Middle East ally, accounting for 3.0% of all U.S. exports between 2020 and 2024. Moreover, the war has functioned as a demonstrative arena for U.S.-produced defense technologies, notably the Iron Dome missile defense system co-developed by Rafael and RTX. The deployment of this system during the conflict has increased its global visibility, which may further boost its international marketability. These events have led to a boost in the US Aerospace and Defense volatility and returns, especially in the mid-caps. If comparing Table 2 (pre-2022) and Table 3 (December 2024), we see a clear change in the top 10 biggest arms manufacturers stating a shift from the “Big Five”

prime Contractors firms involved in manufacturing and supply chain activities more than traditional prime contractors and have begun to value pure-play defense technology leaders with Palantir, which made its first appearance at the top at $178 billion of market capitalization.

Table 2 – *Top 10 Biggest US A&D Firms by Market Capitalization (January 2021)*

#	Company	Subsector	Market Cap ($bn.)
1	Boeing	Prime System Contractors	164.170
2	Raytheon Technologies	Prime System Contractors	125.633
3	Honeywell	Manufacturing: Systems, Subsystems, Components, and Hardware	121.808
4	Lockheed Martin	Prime System Contractors	89.553
5	General Electric	Manufacturing: Systems, Subsystems, Components, and Hardware	66.977
6	Eaton	Manufacturing: Systems, Subsystems, Components, and Hardware	60.932
7	General Dynamics	Prime System Contractors	57.107
8	Northrop Grumman	Prime System Contractors	55.379
9	Amphenol	Manufacturing: Systems, Subsystems, Components, and Hardware	46.449
10	L3 Harris	Manufacturing: Systems, Subsystems, Components, and Hardware	40.575
		Total	828.581

Source: Own elaboration using data from FacSet

Table 3 - *Top 10 Biggest US A&D Firms by Market Capitalization (December 2024)*

#	Company	Subsector	Market Cap ($Bn.)	Total Return
1	Palantir	Technology/C4ISR	178.46	167.47%
2	General Electric	Manufacturing: Systems, Subsystems, Components, and Hardware	177.86	97.67%
3	Raytheon Technologies	Prime System Contractors	154.60	20.75%
4	Honeywell	Manufacturing: Systems, Subsystems, Components, and Hardware	145.18	17.55%
5	Boeing	Prime System Contractors	133.46	-20.71%
6	Eaton	Manufacturing: Systems, Subsystems, Components, and Hardware	130.02	75.79%
7	Lockheed Martin	Prime System Contractors	113.85	24.01%
8	Amphenol	Manufacturing: Systems, Subsystems, Components, and Hardware	84.01	59.25%
9	Parker Hannifan	Manufacturing: Systems, Subsystems, Components, and Hardware	81.90	73.06%
10	Transdigm	Manufacturing: Systems, Subsystems, Components, and Hardware	71.07	65.81%
		Total	1270.41	580.65%

Source: Own elaboration using data from FacSet

If we analyze their skewness and kurtosis levels, we can also denote changes across periods. Before February 2022, return distributions exhibited mild left-skewness and leptokurtosis; however, both asymmetry and tail fatness intensified during the Ukraine war and reached a peak during the Israel–Gaza phase. The negative skew value increases to a considerable extent for Subsector 3 (-3.6) and Subsector 4 (-1.6), indicating a heightened probability of substantial single-day losses. Concurrently, kurtosis (see Table 5) exhibits a notable increase to 31 for Subsector 3 and approaches double digits for Subsector 2 and Subsector 4, thereby confirming the presence of very fat tails. Conversely, the market proxy's kurtosis maintains a near-normal level (< 2), However, the skew and kurtosis of the MSCI

USA equal-weighted index remain relatively stable, indicating that the recent conflicts have led to increased volatility in the defense sector and also to a shift in the shape of the distribution, with more of the probability mass concentrated in the extreme negative tail. This supports Azimli & Kalmaz (2025), who demonstrated that the U.S. defense benchmark can mitigate tail risk and reduce realized kurtosis during wartime.

Table 5 - *Skewness and Kurtosis levels per period.*

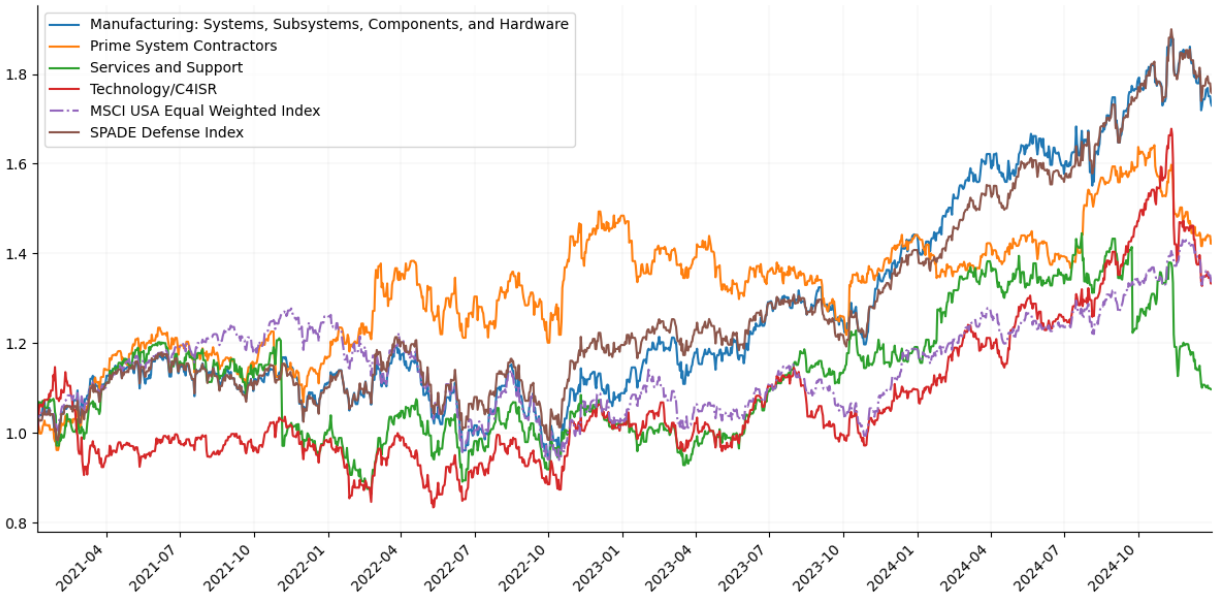
	#	Prime System Contractors	Manufacturing	Services and Support	Technology/C4ISR	MSCI USA Equal Weighted Index
Pre-War (2021-01-01 to 2022-02-22)	**Skewness**	-0.168	-0.434	-0.342	-0.672	-0.263
	Kurtosis	1.179	1.667	2.247	2.573	0.385
Ukraine War (2022-02-24 to 2024-12-31)	**Skewness**	-0.128	0.225	-1.986	-0.647	-0.143
	Kurtosis	1.194	5.338	18.646	4.788	1.814
Israel Conflict (2023-10-07 to 2024-12-31)	**Skewness**	-0.145	1.689	-3.587	-1.558	-0.21
	Kurtosis	1.988	16.514	31.314	11.712	1.204

Source: Own Elaboration using data from FactSet

IV. RESULTS

AS stated in the Methodology overview, we are conducting the log-returns of each Industry subsector compared to the MSCI USA Equal Weighted Index before and after the Ukraine War, and after the Israel-Hamas conflict outbreak on October 7th, 2023. The data presented in Table 4 shows the arithmetic average of the daily log returns of each subsector and index per conflict period, which was obtained by calculating the equally weighted daily price of each subsector and then calculating the daily log returns.

Figure 5 - *Daily Cumulative returns (2021-2024)*



Source: Own Elaboration using data from FactSet

As illustrated in Figure 5, a comparison has been made of the daily cumulative log returns per subsector with those of our benchmark. The data indicates a marked increase in the defense subsectors, particularly among war onsets. A notable significant co-movement exists during the Ukraine period for Prime Contractors, which slows down but persists over the period until the Israel–Hamas outbreak as seen in Table 6. This finding concords with Zhang et al. (2022), who indicate these bigger companies could benefit from the growth in defense budget given the shift of Western countries towards a more rearmed policy, which suggests an optimistic fundamental for long-term investors about the growth and valuation of U.S. Defense contractors. At the same time, the MSCI experienced a dramatic decline in

returns as investors shifted towards other safe-haven assets. Around the 4th quarter of 2022, the Defense Market experienced a sharp increase as the Earnings Reports of the industry's comps confirm the initial hypothesis of investors at the beginning of the war, and extending to other subsectors such as Technology/C4ISR, driven by the shift the war is taking towards more autonomous, cyber-related further highlighted in Table 6 where is remarkable the strong consistent trend it followed over the periods. This increase intensifies with the Israel-Hamas conflict corresponding to the strong and close relationships the US has with Israel, which led to a bigger involvement of U.S. defense firms in this conflict, especially in Manufacturing amid accelerated munitions and spare parts production and deployment contracts that were awarded. In Table 6, where the average daily returns per period are exhibited showcase Manufacturing exhibited superior performance in comparison to the market over the entire period, followed by the SPADE Defense Index, since, as seen in Table 1, Manufacturing is the biggest subsector constituent.

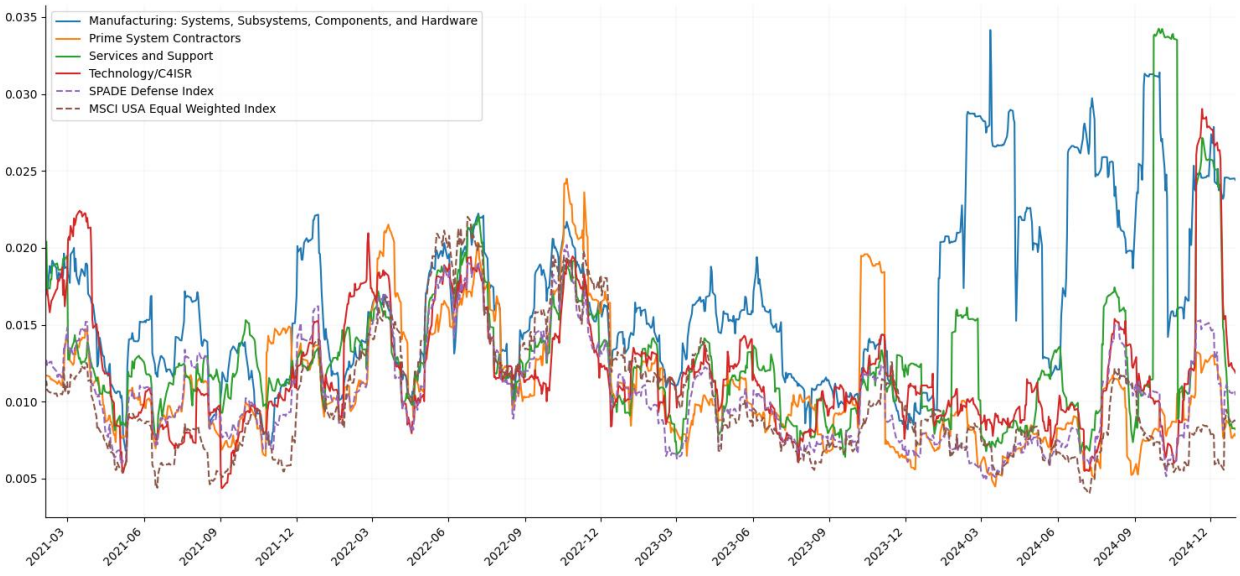
Table 6: *Average Daily Log Returns per period*

	Prime System Contractors	Manufacturing	Services and Support	Technology/C4ISR	SPADE Defense Index	MSCI USA Equal Weighted Index
Pre-War (2021-01-01 to 2022-02-22)	0.070%	0.030%	0.030%	−0.05%	0.030%	0.050%
Ukraine War (2022-02-23 to 2023-10-06)	0.001%	0.040%	0.080%	0.040%	0.030%	-0.020%
Israel Conflict (2023-10-06 to 2024-12-31)	0.050%	0.130%	−0.02%	0.090%	0.120%	0.080%
Overall Period	0.040%	0.067%	0.030%	0.030%	0.060%	0.030%

Source: Own Elaboration using data from FactSet

To assess subsector risk, we examined the standard deviation of log-returns over the three distinct periods, as plotted in Figure 7 and summarized in Table 7. As the average daily log returns, Table 7 shows the average standard deviation of the daily log returns of each subsector and index across the periods.

Figure 6 - *Daily Standard Deviation of Log Returns*



Source: Own Elaboration using data from FactSet

Similar to their return profiles, volatility and returns exhibit strong co-movement concentrated during active conflict phases. From 2021 to 2024, all four SPADE-Defense subsectors recorded daily volatilities that were significantly higher than those of the MSCI USA Equal Weighted Benchmark and slightly higher than the overall SPADE Index. This is due to the SPADE Index's broader diversification and equal weighting across subsectors. However, it is shown that not all the subsectors react the same way, Prime System Contractors experienced sharp spikes on the very days each conflict began, only to calm rapidly thereafter as short-term positions rolled out; as a result, its average σ declined from one episode to the next. By contrast, both Manufacturing and Services & Support experienced an upward drift in volatility across all periods. Manufacturing experienced this trend in part because many of its constituents are small-cap firms whose equity is more susceptible to news. Services and Support subsectors experienced this trend because successive mobilization and sustainment waves maintained a highly volatile operational timing. At the same time, it is interesting how half of the volatility subsectors decreased from one conflict to another, which is the case of Prime Contractors and Technology/C4ISR. These findings are in line with Klein's (2024), who demonstrates that volatility spikes are distributed unevenly, even within a single industry. Moreover, the results concur with the findings of Gurdgiev et al. (2022) who document that U.S. involvement in conflict initially generates abnormal volatility in Prime System Contractors' stocks (as seen in Figure 6), but it erases it as the conflict gets priced in and adjusted.

Collectively, our findings reveal that, although all defense subsectors become riskier during geopolitical shocks, only manufacturing and services, and support sustain elevated volatility once a crisis begins. Meanwhile, prime contractors and technology/C4ISR exhibit pronounced, yet temporary, volatility surges at the onset of conflict.

Table 7 - *Standard Deviation of the Daily Log Returns per Period*

	Prime System Contractors	Manufacturing	Services and Support	Technology/C4ISR	SPADE Defense Index	MSCI USA Equal Weighted Index
Pre-War (2021-01-01 to 2022-02-22)	1.070%	1.420%	1.830%	1.260%	1.060%	0.910%
Ukraine War (2022-02-23 to 2023-10-06)	1.330%	1.530%	1.320%	1.290%	1.230%	1.340%
Israel Conflict (2023-10-06 to 2024-12-31)	0.950%	2.160%	1.510%	1.250%	0.920%	0.810%
Overall Period	1.15%	1.720%	1.540%	1.270%	1.090%	1.020%

Source: Own Elaboration using data from FactSet

In the section that follows, the Sharpe ratio analysis is addressed. This analysis is performed using the daily log returns and the standard deviation of them, which were previously calculated, as well as the 3-month US Treasury bill, which is employed as a risk-free rate.

Tabla 8 - *Sharpe Ratio Analysis Results per Subsector and Period*

	Prime System Contractors	Manufacturing	Services and Support	Technology/C4ISR	SPADE Defense Index	MSCI USA Equal Weighted Index
Pre-War (2021-01-01 to 2022-02-22)	0.201	0.819	-0.471	-0.801	0.399	0.726
Ukraine War (2022-02-23 to 2023-10-06)	0.654	0.083	0.185	0.579	0.758	0.095
Israel Conflict (2023-10-06 to 2024-12-31)	1.256	0.469	-0.456	0.945	1.742	1.152
Overall Period	0.505	0.274	-0.055	0.157	0.641	0.220

Source: Own Elaboration using data from FactSet

Table 8 provides the Sharpe Ratio levels per subsector/index across the different sample periods and overall. The results reveal that the Prime System Contractors subsector, despite generating moderate returns and shown in Table 6, it delivered the most consistently attractive risk-adjusted returns of all U.S Aerospace and Defense subsectors overall supporting the position of investors in using these contractors as a hedge against the general market reaction to war conflicts where the U.S. becomes publicly involved (Gurdgiev et al., 2022) while maintaining relatively low volatility. This resulted in Sharpe ratios surpassing those of all other subsectors. On the other hand, the Manufacturing subsector failed to turn its elevated volatility into equal excess returns. Although hardware producers benefited from major capital expenditure orders during each crisis, their risk-adjusted performance remained limited, suggesting that production-line bottlenecks and the subsector's exposure to small-cap companies limited the subsector to absorb and sustain conflict-driven upside. This uneven outcome within a single industry reflects Klein's (2024) observation that

volatility spikes are not uniform across companies, even during periods of heightened geopolitical risk. Regarding Technology/C4ISR subsector, even though it still is below our benchmark, it exhibits improving Sharpe Ratio especially during recent conflicts due to it high yet stable risk and increasing returns, making it a reliable investment given the turmoil the war field at a digital and technological level which could boost these new generation of companies specializing in offering these solutions.

Overall, our results denote that the SPADE Defense Index outperformed the MSCI USA Equal Weighted Index, but more interestingly, it also outperformed all individual subsectors in terms of risk-adjusted returns. By combining increasing budget expenditures in arms manufacturing, consistent returns of prime contractors, and momentum in technology, command, control, communications, computers, intelligence, surveillance, and reconnaissance (C4ISR), the SPADE Defense Index delivers the most robust Sharpe ratio during heightened geopolitical conflicts. These findings are consistent with those of Jarlén & Jönsson (2015), Singh et al. (2022), Zhang et al. (2022), and Gheorghe and Panazam (2024). The study reaffirms Blum's (2019) finding, which notes that the US Defense industry benefits from lower volatility as it doesn’t rely mainly on exports. It also confirms the importance of portfolio optimization using the TrueCap weighting methodology, which considers and weights each company based on its aerospace and defense business, reducing the undue impact of war conflicts on commercial business activities.

VI. CONCLUSION AND FURTHER RESEARCH

This study aimed to expand the limited literature on the impact of recent and ongoing military conflicts on the U.S. aerospace and defense (A&D) industry, focusing on disaggregated subsector analysis, given its status as the foremost producer and exporter of advanced military technologies. In doing so, the research contributes to filling a notable gap in current academic and financial discourse, which tends to treat the U.S. defense sector as homogeneous despite its complex and diverse structure, especially in recent conflicts that have brought to the battlefield advanced defense technologies. Through the Sharpe Ratio approach, we uncover how geopolitical shocks affect the risk-return relationships of specific defense-related industries, providing more granular insights for investors and future studies.

Besides enriching the current literature in the positive effects of conflict shocks in the US Defense Industry risk returns relationship, we can suggest that despite being a leading industry that has outperformed the market during the Ukraine-Russia and Israel-Hamas conflicts, it doesn't behave equally. As we observed, in response to these conflicts, the subsector's performance varied notably. Prime System Contractors consistently offered the most attractive risk-adjusted returns during both conflict periods, reinforcing their role as stable, defensive assets. In contrast, the manufacturing subsector exhibited elevated volatility without substantial gains, indicating a limited ability to convert geopolitical momentum into sustained performance. Meanwhile, technology/C4ISR firms demonstrated improving Sharpe ratios, reflecting growing investor confidence in digital warfare capabilities and signaling long-term strategic appeal.

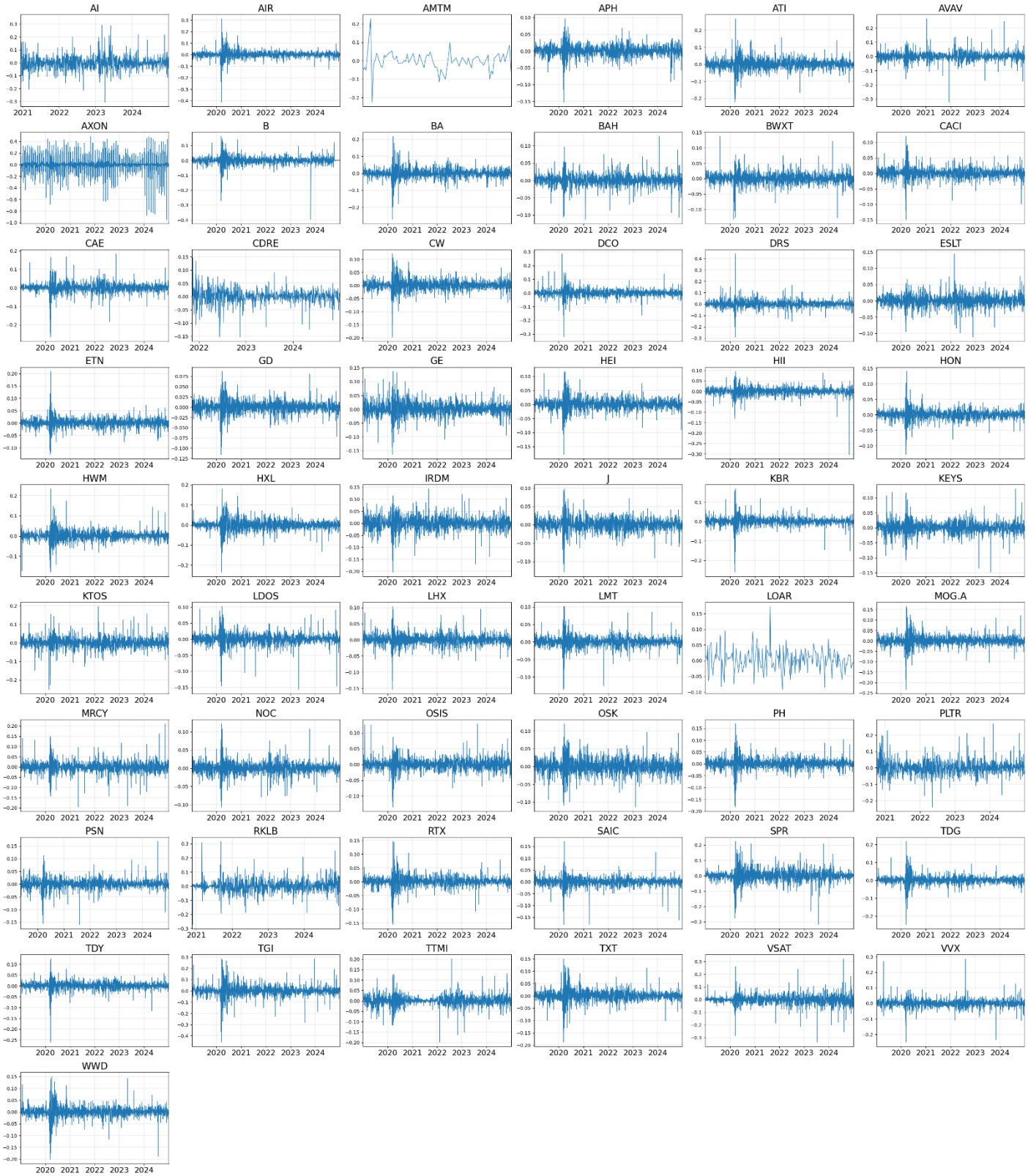
Overall, we find that the SPADE Defense Index outperformed both the MSCI USA Equal Weighted Index and each subsector, confirming its role as a robust, conflict-resilient benchmark. These results reaffirm the importance of diversification across defense subsectors and portfolio optimization, particularly when military tensions and geopolitical risks are not just isolated incidents but rather systemic and ongoing. Furthermore, the behavior of the index could be used as an early indicator of broader shifts in defense-related capital flows. For institutional investors, this could support tactical allocation decisions within equities and across asset classes.

Due to the varying performance of different subsectors, future research should focus on optimizing aerospace and defense portfolios using models such as Markowitz or Black–Litterman to more effectively capture diversification benefits. Additionally, analyzing

industry's role as a safe haven asset by comparing its performance to that of alternative assets, such as gold and Bitcoin, during geopolitical crises would be valuable. These analyses would support more informed investment strategies and risk management during periods of global war instability.

VII. APPENDIX

Figure 6 -*SPADE Defense Index Log Returns (2020-2024)*



Source: Own Elaboration using data from FactSet

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Por la presente, yo, Mario Laureano Simón Alonso, estudiante de E2 + Business Analytics de la Universidad Pontificia Comillas al presentar mi Trabajo Fin de Grado titulado "THE MODERN INVESTOR'S DILEMMA: INVESTING IN DEFENSE COMPANIES AN ANALYSIS OF THE IMPACT OF WAR CONFLICTS ON THE RISK-RETURN RELATIONSHIP IN THE U.S. DEFENSE INDUSTRY", declaro que he utilizado la herramienta de Inteligencia Artificial Generativa ChatGPT u otras similares de IAG de código sólo en el contexto de las actividades descritas a continuación [el alumno debe mantener solo aquellas en las que se ha usado ChatGPT o similares y borrar el resto. Si no se ha usado ninguna, borrar todas y escribir "no he usado ninguna"]:

1. **Brainstorming** de ideas de investigación: Utilizado para idear y esbozar posibles áreas de investigación.

2. **Referencias**: Usado conjuntamente con otras herramientas, como Science, para identificar referencias preliminares que luego he contrastado y validado.

3. **Metodólogo**: Para descubrir métodos aplicables a problemas específicos de investigación.

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Afirmo que toda la información y contenido presentados en este trabajo son producto de mi investigación y esfuerzo individual, excepto donde se ha indicado lo contrario y se han dado los créditos correspondientes (he incluido las referencias adecuadas en el TFG y he explicitado para que se ha usado ChatGPT u otras herramientas similares). Soy consciente de las implicaciones académicas y éticas de presentar un trabajo no original y acepto las consecuencias de cualquier violación a esta declaración.

Fecha: 04/06/2025

Firma: ___Mario Laureano Simón Alonso_____