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Geopolitical Risk and Defence Stocks:

An empirical analysis of defence stock market performance

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Abstract

This study aims to investigate the market performance of defence stocks, with a focus on geopolitical risk. The recent developments related to geopolitical risk, the potential changes in the market sentiment towards defence firms in connection to these and the little examination of the relationship between defence stock market performance and geopolitical risk open the possibility for contributing a new perspective on defence stocks. This study therefore analyses defence stock market performance in the U.S. and European markets during 2010–2023, utilising pooled panel data regression models estimated with OLS and incorporating a geopolitical risk index as well as different dummy variables to study the effect of changes in geopolitical risk. Our findings show that defence firms perform worse than control firms in general and that increased geopolitical risk affects stock markets negatively. However, defence firms are found to be less negatively or even positively affected by increased geopolitical risk. Defence stock performance in European markets is seen to be positively affected by increased geopolitical risk or the event of war. The performance of American defence stocks is only shown to be less negatively affected by increased geopolitical risk than that of the control firms.

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1 Introduction

This study examines the stock market performance of defence firms in the U.S. and European markets, and the extent to which geopolitical risk influences their performance. S&P Global (2024) describes that geopolitical tensions are increasing and that there has been a recent shift to a world based firmly on geopolitical risk. In the discussion, the COVID-19 pandemic and the Russia-Ukraine conflict are mentioned as events that have reorganised global structures in a significant way.

The start of the Russia-Ukraine war and recent developments in the Middle East have spurred reactions from the Western world and caused action to be taken, not the least financial such. Between January 24th 2022 and January 15th 2024, Ukraine has received in total 68.72 billion EUR from the U.S. and 84.99 billion EUR from EU institutions in financial, military and humanitarian aid (Statista, 2024). Furthermore, the U.S. has provided Israel with more military aid than it has to any other country since the second world war, but the U.S. aid for Israel is being debated due to the high impact on civilians that Israel's offensive in Gaza has had (Taylor, 2024). A type of entity which armed conflict can be thought to affect financially as well are defence firms. In the DefenseNews (2024) list of the top 100 defence firms in the world based on defence revenue for the years 2022 and 2023, there are clear indications of this in the defence sales growth figures for the companies. Out of 100 firms listed, 77 firms experienced growth in defence sales from year 2020 to year 2021, and 49 firms from year 2021 to year 2022, indicating that the Russia-Ukraine war may have had a significant effect on the earnings of defence firms.

Not only financial impact is observed in connection to this event, but also changes related to the overall sentiment towards national defence and defence firms. Causevic, Beslik and Causevic (2022) note that recent developments following the start of the war between Russia and Ukraine indicate a shift in the financial markets' view on the defence industry. Examples that they mention include the head of the German defence industry lobby group BDSV arguing that the defence industry should be recognised as a positive contributor to social sustainability under the EU ESG Taxonomy (Ainger & Arons, 2022), and the Swedish bank SEB updating their sustainability policy, permitting investments in defence companies for some of its funds (Skandinaviska Enskilda Banken AB, 2022). Some European governments have also made indications of significant amendments to their defence spending. One example is the German chancellor, Olaf Scholz, announcing a drastic increase in defence spending in his *Zeitenwende* speech (Solomon, 2022).

The recent developments, indicating a potential shift in the investor sentiment regarding defence stocks and coinciding with an elevated level of geopolitical risk, make it interesting to investigate whether or not there is a relationship between changes in geopolitical risk and defence stock market performance. The market performance of defence firms is studied in different ways in existing literature. Some researchers consider defence stocks to be so-called sin stocks (e.g. Sagbakken & Zhang, 2021), and defence firms' market performance is therefore studied to some extent in the sin stock literature. Others study defence stocks exclusively, and often focus on factors such as the effect on defence stock market performance of different news (e.g. Capelle-Blancard & Couderc, 2008; Shapiro, Switzer & Mastroianni, 2011) or aspects such as conflict involvement, political factors and differences in policy (e.g. Gurdgiev, Henrichsen & Mulhair, 2022). The effect of changes in geopolitical risk on equities more broadly is examined by several researchers (e.g. Umar et al., 2022; Będowska-Sójka, Demir & Zaremba, 2022), but the potential relationship between changes in geopolitical risk and defence stock market performance remains largely unexplored.

This study will examine the stock market performance of the defence firms with the highest defence sales, focusing on how geopolitical risk affects the performance and adjusting for profitability. Focusing on geopolitical risk will contribute a perspective on defence stock market performance which is different from that in previous studies. An adjustment for the potential changes in profitability for defence firms caused by increased geopolitical risk is deemed necessary to focus on the aspects related to potential changes in the market sentiment towards defence firms due to changes in geopolitical risk. The study focuses on the U.S. and European markets and the period January 2010 to December 2023. As much of previous literature focuses on either the U.S. or the European markets, including these will allow for comparison with previous findings and between the markets. A comparison between the markets could be interesting given potential differences in attitude towards defence and weapons. The studied period includes the recent developments and corresponding changes in geopolitical risk as well as several previous, potentially interesting time periods of different policies.

The data consists of monthly observations of returns and different explanatory variables for 80 companies within the defence industry and a control group of 120 companies within other manufacturing industries in the U.S. and European markets from January 2010 to December 2023. Pooled panel data regression models are estimated with OLS, where a geopolitical risk index and different dummy variables are incorporated to study the effect of changes in geopolitical risk. Control variables that are considered relevant based on previous literature and which account for potential changes in profitability are also included.

The results show that, when controlling for other factors such as profitability, there is a negative relationship between returns and the trait of being a defence firm and that geopolitical risk negatively affects the market performance of the stocks in the sample. However, when separating out the effect of increased geopolitical risk on defence stock returns, a less negative or even positive effect is observed for these. A positive effect on defence stock returns by increases in geopolitical risk or the event of war is observed for European firms. American defence firms only display a less negative effect on stock returns by increased geopolitical risk. The difference between the markets could potentially be attributed to the difference in proximity to the Russia-Ukraine war, which coincides with the largest changes in the geopolitical risk index used in this study. The observed effects are however small, indicating that large changes in geopolitical risk are necessary for a substantial effect on returns to be observed.

Section 2 will present previous literature related to the studied area. Then, the data and applied methodology will be described in Section 3, followed by the study’s results and an analysis of these in Section 4. Lastly, the conclusion is presented in Section 5.

2 Related Research

This section starts by describing the extent to which defence firms are included in the sin stock literature and presenting an overview of the sin stock literature. It then proceeds to cover the defence stock literature related to market performance. Lastly, it provides an overview of the literature covering the effect of geopolitical risk on stock markets.

2.1 Classification of defence stocks as sin or non-sin stocks

As opposed to sustainable investments, so-called sin stocks are typically associated with immoral activities, and therefore shunned rather than favoured by some investors for ethical reasons. Hong and Kacperczyk (2009) explain that sin stocks, theoretically, should be relatively cheap and experience larger expected returns than control firms due to the neglect by investors and higher litigation risk. Several researchers examine the market performance of sin stocks using varying sin stock classifications.

Previous literature studying the performance of sin stocks largely focus on the so-called triumvirate of sin, consisting of alcohol, tobacco and gambling. Hong and Kacperczyk (2009) is one such study that focuses on the U.S. market, and the authors point out that these three consumer product groups are due to their addictive nature and potential negative social effects viewed as sinful. The authors explain that they omit the defence industry since they consider it not to be clear that defence is viewed as sinful by Americans. Salaber (2007) also chooses to focus on the triumvirate of sin, arguing that the defence sector should be excluded since it is not homogenous to the same extent as the alcohol, tobacco and gambling sectors. She argues that European companies within the defence industry have broad diversity in their activities, and that the addictive aspect of the three other sinful products together with them being considered sinful from a religious perspective makes them more clearly classified as sin stocks. In a later study, Salaber (2009) uses the same specification.

As a slightly less conservative classification of sin industries, several studies include firms in the business of weapons. Blitz and Fabozzi (2017) is one such study, which classifies the alcohol, tobacco, gambling and weapon industries as sin industries. Other studies, however, use an even broader classification of sin industries. An example is the study by Fabozzi, Ma and Oliphant (2008), which includes the adult entertainment, biotech and weapon industries in addition to the triumvirate of sin in their analysis of sin stocks. The authors highlight that sin classification of an industry is subject to culture and the overall zeitgeist, especially when it comes to industries other than those included in the triumvirate of sin. A study which emphasises this further is that by Sagbakken and Zhang (2021). They choose to in addition to the triumvirate of sin and defence stocks include stocks in carbon-intensive industries as new sin stocks.

Some authors choose to use both a more conservative and a broader classification. Borgers et al. (2015) use both a narrower definition of sin stocks, which includes the alcohol, tobacco and gambling industries, and two broader definitions. The second broadest definition includes the triumvirate of sin and firms which have operations merely related to these industries. As their broadest definition, the authors also include firms with weapons, firearms and nuclear operations.

In summary, the classification of the defence industry as sin or non-sin varies within previous literature. Most research that chooses a classification that extends beyond the triumvirate of sin includes at least some defence-related industries. Furthermore, more recent studies use broader classifications and different classifications to a larger extent, which includes either the defence industry in its entirety or some defence-related industries. Therefore, the sin stock literature and its findings could be relevant to discuss when discussing defence stock performance.

2.2 Sin stock market performance

Hong and Kacperczyk (2009) is one of the first studies analysing sin stock performance. The authors study all stocks listed on the New York Stock Exchange (NYSE), NASDAQ and AMEX during the period of 1962 to 2006. The authors use the Fama and French (1997) classification into 48 industries and select the alcohol, tobacco and gambling industries as sin industries. They describe that a second screening of companies listed on the NYSE, NASDAQ and AMEX is conducted on a sector level, and that a company is identified as a sin stock if any of its segments is also deemed to belong to any of the three industries of interest.

In order to study the sin stocks returns, Hong and Kacperczyk (2009) use time-series regressions. The authors start by estimating the CAPM and then use three additional factor models, adding to the regression model a size factor, then a value factor and lastly a momentum factor. Cross-sectional regressions are also conducted to further study whether sin stocks perform better than the control stocks. The authors find that sin stocks outperform the control group in the time-series regressions, even when adjusting for additional factors. This outperformance is also indicated by the results of the cross-sectional regressions. The price effect that is found is as high as 15–20%, which they attribute to large institutional investors choosing not to invest in sin stocks due to societal norms.

Other authors have largely used an approach similar to that of Hong and Kacperczyk (2009). One such author is Salaber (2007), who uses the same specification of sin stocks as Hong and Kacperczyk (2009), the CAPM model and a three-factor model to examine the performance of sin stocks in 18 European markets over the period 1975–2006. The author focuses on whether aspects such as religion, litigation risk and taxation have any effect on sin stock performance. She finds a sin stock outperformance, that Protestant investors require a considerable sin stock premium whereas Catholics do not, and that higher litigation risk and excise taxation yield a higher sin stock premium. In a later study, Salaber (2009) studies the performance of sin stocks in the U.S. market over the period 1926–2005 using conditional factor models and focuses on the performance over different business cycles. She then finds no evidence of a premium specific for sin industries, since the outperformance she finds for sin stocks during recessions also can be found using comparable firms.

Studies that include the defence industry to some extent as a sin industry largely follow the approach used by Hong and Kacperczyk (2009). An example is Blitz and Fabozzi (2017), who specify several factor models to investigate the performance of sin stocks in the U.S., European, Japanese and global markets during varying periods between July 1969 and December 2016. Based on their results, the authors conclude that after controlling for certain asset pricing factors, no evidence of a sin premium can be found. Another study, which follows the methodology of Hong and Kacperczyk (2009) even more closely, is that by Sagbakken and Zhang (2021). The authors also use both time-series regressions and cross-sectional regressions to study the performance of sin stocks, but extend their analysis to include a five-factor model for the time-series regressions and focus on the European market rather than the U.S. market. Furthermore, the studied period is more recent than that studied by Hong and Kacperczyk (2009), covering the years 2006–2020. The authors, in line with Blitz and Fabozzi (2017), do not find any robust general evidence of outperformance by the sin stocks.

Fabozzi, Ma and Oliphant (2008) also include defence-related industries, and examine the period January 1970 to June 2007 and 21 different countries using a simpler model specification. A sin portfolio is constructed based on their definition of sin stocks, and the performance of this portfolio is then examined using the CAPM and simple excess returns. They find that the sin portfolio outperforms the market consistently over several time periods and across different countries. The authors also point out a potential reason for sin stock outperformance, namely, it being the payoff for not adhering to social norms.

Another study that includes defence-related industries is Borgers et al. (2015). The authors adopt a slightly different approach to examining sin stock performance. They classify sin stocks as socially sensitive and aim to investigate how social considerations affect U.S. mutual funds' holdings and returns during the period 2004–2012. The authors are thereby investigating mutual funds' exposure to sin stocks and the returns related to those exposures. By performing pooled cross-sectional regressions, rather than the commonly used factor models, they find a financial payoff connected to holding sin stocks. However, this result does not hold as the definition of sin stocks becomes broader.

To summarise, it is not only the sin stock classifications that vary among existing sin stock literature, but the results do as well. Whereas some authors find an outperformance by sin stocks, others find that this outperformance can be explained by other factors, that the results are not robust or do not find any evidence of a sin stock premium. This is the case regardless of the inclusion of defence related industries.

2.3 Defence stock market performance

So far, the defence industry itself is not studied as extensively as sin stocks. However, one study that focuses purely on the defence industry is that by Capelle-Blancard and Couderc (2008). The main focus of the study is how investors in defence firms react to different kinds of news or events. Capelle-Blancard and Couderc (2008) study 58 of the defence firms with the highest defence sales from different markets during the period of January 1995 to May 2005 using an event study approach. They find that while defence stocks react in a similar way as other industries to most types of news, the defence industry displays some features that distinguish it from other industries. Two such features are that public military spending is a key price mover for defence stocks, and that geopolitical context and news related to geopolitics affect defence stocks in a particular way.

Another study that applies an event study approach is that by Shapiro, Switzer and Mastroianni (2011). The authors examine how the performance of the largest U.S. defence contractors' stocks is affected by news related to war and peace. The events that are studied are the Vietnam War, the Six Day War, the Yom Kippur War, the Falkland Islands War and the Gulf War. The defence firms are identified using a list of the largest defence contractors from the U.S. Department of Defense, resulting in that between 63 and 69 defence firms are included in the study, depending on data availability for each event. Shapiro, Switzer and Mastroianni (2011) find that the majority of their results indicate that war outbreaks, announcements increasing the likelihood of a war outbreak or announcements of an escalation of an ongoing war coincide with positive abnormal returns for defence stocks. Further, the authors find that peace-related news are mostly associated with negative abnormal returns. However, they point out that the potential for ambiguity in their results means that their results merely on balance suggest that a defence stock portfolio generates abnormal returns as a reaction to news related to war and peace.

A more recent study which focuses on defence stocks is conducted by Gurdgiev, Henrichsen and Mulhair (2022). They explore how stock prices of the five largest U.S. defence companies are affected by direct and indirect U.S. involvement in conflicts, Republican or Democratic party control of the U.S. congress and presidency, and announcements of new budgetary allocations for the U.S. military. The authors use a different approach than Capelle-Blancard and Couderc (2008) and Shapiro, Switzer and Mastroianni (2011), utilising a fixed effect panel regression, with return in excess of the NYSE composite index as the dependent variable and dummy variables for the circumstances of interest. They find that direct involvement in conflict significantly and positively affects performance of the defence companies. According to the authors, defence stocks are used as a hedge against an adverse market reaction to a conflict announcement since the shares generate abnormal return in comparison to the market. A lagged dummy variable for direct involvement is also found to have a significant coefficient but with a negative sign, indicating that the hedge created by defence stocks is only short term. The authors state that their evidence overall suggests that defence stocks perform better during periods characterised by higher probability of greater geopolitical volatility, unexpected news related to conflict, potential escalation of conflict and lower informational efficiency in markets.

In summary, the performance of defence stocks has been investigated to a lesser extent than sin stocks, and with an emphasis on specific aspects affecting their returns. Some factors which are accounted for within existing literature are the effect of news, conflict involvement and differences in policies. According to some of the findings, defence stock performance improves as a response to conflicts, conflict announcements and greater geopolitical risk and is more affected by geopolitical aspects than other firms.

2.4 Geopolitical risk

In the geopolitical risk literature, some researchers attempt to construct a measurement of geopolitical risk. One study which does so is that by Caldara and Iacoviello (2022). The authors construct a measure of adverse geopolitical events and the risks associated with these. Their recent Geopolitical Risk (GPR) Index is constructed from 1985 up until the present. They construct the index using an algorithm that searches ten major English-language newspapers for keywords related to geopolitical risk, such as ‘terror’, ‘invasion’ and ‘war’, excluding results where these are found in combination with words such as ‘movie’, ‘game’ and ‘history’. The index is based on the number of articles discussing increasing geopolitical risks relative to the number of published articles in total.

Several studies that investigate the effects of geopolitical risk on financial markets utilise Caldara and Iacoviello’s (2022) constructed GPR Index as a proxy for geopolitical risk. One such study is Umar et al. (2022), where the authors study how geopolitical risk resulting from the Russia-Ukraine conflict affects Russian and European financial markets during February 2020 to March 2022. They find that most types of assets have a mixed relationship with geopolitical risk, meaning that the relationship is neither strictly positive nor negative, and that in normal market conditions geopolitical risk causes changes in asset returns. Another study utilising the GPR Index and focusing on the Russia-Ukraine conflict is that by Będowska-Sójka, Demir and Zaremba (2022). The authors study the effect of the ongoing warfare between Russia and Ukraine on different asset classes. Several markets are studied during the period of January 2021 to June 2022, and they find that the effect is uneven and asset-class specific. Whereas some assets, such as equities, are shown to be more sensitive to geopolitical risk, assets such as green bonds, silver, gold, real estate and the Swiss franc are deemed to be the most suitable candidates for hedging against the uncertainty that is caused by military conflicts due to their resistance to changes in geopolitical risk. Furthermore, some of their results indicate that there is a negative correlation between geopolitical risk and stock markets for developed markets.

The relationship between geopolitical risk and financial markets has also been studied by researchers that are not utilising the Caldara and Iacoviello (2022) GPR Index. However, the defined focus of these articles tends not to be on geopolitical risk specifically, but instead on factors such as war risk or events affecting the geopolitical risk level. For example, Rigobon and Sack (2005) study the effect of war risk on different financial assets in the U.S. financial markets. They limit the scope of the study to the Iraq war and find that increased war risk results in lower equity prices and U.S. Treasury yields, a wider credit spread for lower-grade corporate bonds, the U.S. dollar depreciating and higher oil prices. Another study is that by Amihud and Wohl (2004), which studies the relationship between the U.S. market's expectations of Saddam Hussein's fall and the prices of stocks and oil as well as exchange rates. They find that an increased probability of Saddam Hussein's fall during the war, and thereby a sooner end to the war, has a significant and positive association with stock prices, causes the U.S. dollar to strengthen against the euro and leads to lower oil prices. Before the war started, however, an increased probability of his fall, potentially indicating a war outbreak, caused gradually lower stock prices.

To conclude, most authors find that events and factors related to geopolitical risk have an impact on the market performance of defence stocks. Whereas some studies utilise a constructed index for geopolitical risk, others focus on the effect of more specific factors related to geopolitical risk. The focus of these studies tends to be broader than just a specific industry and expand across several different asset classes. Furthermore, equities are often found to be sensitive to changes in geopolitical risk, and some studies find a negative association between geopolitical risk and stock performance.

3 Data and Methodology

This section starts with a description of the sample selection and used dataset. Next, the chosen methodology in terms of analysing the defence stock market performance is explained.

3.1 Data

To identify defence firms within the markets of interest, the “Top 100 Defense Companies” ranking published by DefenseNews (2024) is used. The list is published annually and ranks defence firms based on their annual defence sales. This choice is based on Capelle-Blancard and Couderc’s (2008) method of identifying defence firms. Whereas their study only includes firms on the list for 2003, a firm is included in our study if it is on any of the lists from any of the years which are studied, 2010–2023. This allows for a larger sample. Furthermore, both U.S. and European firms are included to investigate potential differences between the markets and compare with previous literature which focuses on either of these geographic areas.

Utilising the list of the top 100 defence firms for the defence firm selection is favoured above an industry classification approach, which is commonly used in the sin stock literature. The primary reason for this is that the firms with the highest defence sales are more likely to be clearly classified as defence firms. The industry classifications related to defence found on the Refinitiv Eikon database are “Arms & Ammunitions Manufacturing”, “Military Aircraft Manufacturing”, “Aerospace & Defense Electronics”, “Drone Manufacturing”, “Aerospace & Defense (NEC)”, “Aircraft Parts Manufacturing”, “Satellite Design & Manufacture”, “Military Clothing & Accessories” and “Military Vehicles Manufacturing”. Many of these include companies which may not be considered defence firms as most of their products or services are not used in national defence, such as producers of weapons which are sold to civilians and firms selling mainly to the aviation industry. This makes the usage of these industry classifications to identify defence firms unsuited for the purposes of this study. Furthermore, the largest defence firms could be considered more likely to be assigned large government contracts. Thereby, these are probably the most affected by events that cause changes in the level of geopolitical risk, such as armed national conflicts, and more relevant for this study. The selected approach aligns with Capelle-Blancard and Couderc (2008), Shapiro, Switzer and Mastroianni (2011) and Gurdgiev, Henrichsen and Mulhair (2022), all of which focus on the biggest defence firms rather than all firms in an industry that could be related to defence.

As for the identification of potential control firms, the industry classifications of firms on the Refinitiv Eikon database are used. Following the same approach as Sagbakken and Zhang (2021), the industries “Industrial Machinery & Equipment”, “Electrical Components & Equipment” and “Heavy Machinery & Vehicles” are selected as the industries to which potential control firms for defence firms belong. However, the fact that only relatively large defence firms with high defence sales are included in the sample needs to be accounted for. This is done by selecting the control firms based on average market capitalization over the studied period, and thereby including the largest firms with available data out of the potential control firms. A better matching can then be achieved between defence firms and control firms.

The chosen time period, January 2010 to December 2023, includes potentially interesting events and periods of different policies regarding defence in both the U.S. and several European countries. In the recent years of the period, larger scale conflicts have escalated and broken out into wars. Figure 1 displays the development of Caldara and Iacoviello’s daily GPR Index, as well as a seven- and a thirty-day average of the index, over the past 14 years. The index reaches its highest level at the start of 2022, which corresponds with the outbreak of the Russia-Ukraine war. After the event, the general level of geopolitical risk appears to be higher than before. This could be interpreted as a shift in the general level of geopolitical risk following the outbreak of the war, which is also insinuated by S&P Global (2024). Such a shift in the level of geopolitical risk further makes the selected time period interesting to study. Furthermore, the period excludes the financial crisis of 2008 and potential distortions this could cause, but includes the Obama and Trump presidencies and thereby time periods of different U.S. defence policies.

Figure 1: GPR Index from January 2010 to April 2024

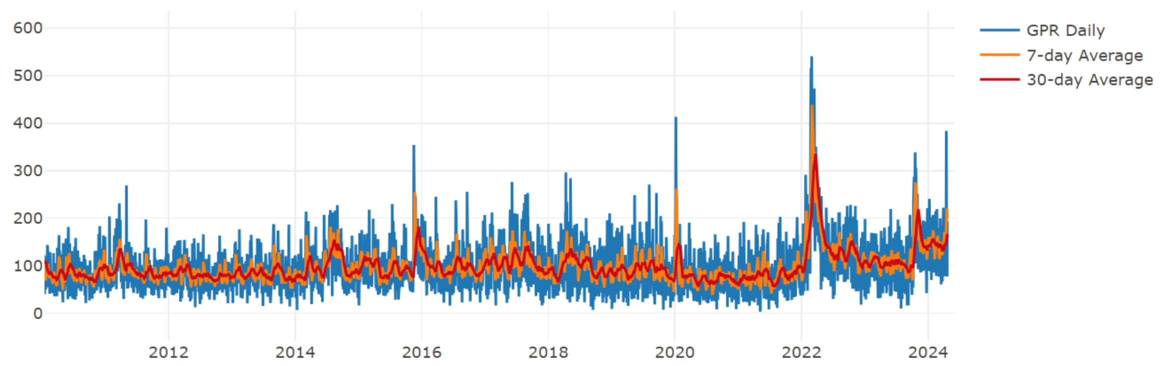

Figure 1 shows Caldara and Iacoviello’s daily GPR Index, seven-day average of the daily GPR Index and thirty-day average of the daily GPR Index from January 2010 until April 2024, retrieved from Geopolitical Risk (GPR) Index (2024) by adapting the interactive graph on the website to the selected time period.

To minimise survivorship bias, unbalanced panel data is used rather than balanced. This way, more defence firms are included in the study and only those for which a variable is completely unobserved during the entirety of the selected time period need to be excluded. Survivorship bias is thereby accounted for to some extent. However, some defence firms listed by DefenseNews (2024) are not included in the study due to lack of data availability. Since the study is examining the market performance of defence stocks, private companies and companies that have merged with or been taken over by other companies and have insufficient historical market data available are sorted out. Nevertheless, companies that have previously been public and for which historical market data is available are included. Furthermore, one firm was identified as both a control firm and a defence firm since it spun off its defence division shortly after the start of the studied period. Given that the firm's operations were non-defence-related for most of the period, it was dropped from the defence stock selection and only included in the selection of control firms. Lastly, firms with negative equity were removed in order for these observations not to skew the results.

After sorting out some of the defence firms according to the description in the previous paragraph, 80 defence firms remain. 58 of these are U.S. firms and 22 are European firms. The sample of control firms is determined to have 50 percent more firms than the defence sample and to have the same weighting between U.S. and European firms as the defence sample. Thereby, 120 control firms are selected in total based on average market capitalization. Out of these 120 firms, 87 are U.S. firms and 33 European firms. The total sample thereby consists of 200 firms.

For the sample of firms, data is collected from Bloomberg for the variables included in the regressions. RET_{it}, the dependent variable, is the monthly stock return in excess of the risk-free rate, expressed in percentage points. Seven control variables are used: $LOGSIZE_{it}$, $BETA_{it}$, $TURN_{it}$, AVG_{it}, $BLEV_{it}$, ROA_{it} and $SALESGR_{it}$. $LOGSIZE_{it}$ is the natural logarithm of the market capitalization in millions of USD for company i in month t. $BETA_{it}$ is the time-varying beta of firm i, calculated using the observations for the last 36 monthly returns up to and including month t-1. $TURN_{it}$ is the monthly share turnover, calculated as the total monthly volume traded divided by shares outstanding for company i in month t. AVG_{it} is the average of the monthly returns for the 12 months preceding month t, expressed in percentage points. $BLEV_{it}$ is the book leverage of company i, and the value at month t is the value recorded as of the end of the previous year. Book leverage is calculated as the total debt divided by the sum of book value of equity and total debt. ROA_{it} is the return on assets for company i as of the end of the previous year, expressed in percentage points. $SALESGR_{it}$ is the sales growth from the year before the preceding year to the preceding year for company i, expressed in percentage points. The risk-free rate and market index used are the Bloomberg generic U.S. 3-month treasury bill and the S&P 500 index for the U.S. firms, and the Bloomberg generic German 3-month treasury bill and the STOXX Europe Total Market Index for the European firms. Monthly observations are collected for stock prices, market capitalization, traded volume, shares outstanding, the risk-free rates and the market indices. Yearly observations are collected for total debt, total equity, return on assets and sales growth. The values for RET_{it}, $LOGSIZE_{it}$, $BETA_{it}$, $TURN_{it}$, AVG_{it}, $BLEV_{it}$, ROA_{it} and $SALESGR_{it}$ are winsorized due to the existence of outliers skewing the analysis.

Additionally, a geopolitical risk index and three dummy variables are utilised. The recent GPR Index by Caldara and Iacoviello (2022) is collected from the data available on Geopolitical Risk (GPR) Index (2024), and constitutes the variable GPR_t. The value recorded for this index is its value at month t. A three-month average is calculated out of this index and constitutes the variable $GPRAVG_t$. DEF_i takes on the value of 1 if the company in question is a defence firms, and 0 if it is one of the control firms. US_i takes on the value of 1 if the company is listed on a U.S. stock exchange, and 0 if it is listed on a European stock exchange. WAR_t takes on the value 1 if the time period in question is after the start of the Russia-Ukraine war and the value 0 otherwise.

In Table 1, sample statistics for the dependent and explanatory variables are presented for the defence and control firms. The sample statistics are presented for the defence firms and the control firms separately. The average for the dependent variable over the time period is approximately one percentage point for both groups. Furthermore, the standard deviation is similar as well. Given that the control firms are selected based on market capitalization, LOGSIZE is very similar between the two groups in all aspects presented below. AVG, TURN and BLEV also display similar properties in terms of the sample statistics. However, the average BETA for the defence firms is relatively large in comparison to that of the control group, and on average the defence firms exhibit slightly lower ROA and SALESGR than the control firms. Looking at all the displayed features of the two groups, the firms are relatively similar overall, and the control firms could therefore be considered suitable as a comparison group.

Table 1: Sample Statistics

	Defence				Control			
	Count	Mean	Median	SD	Count	Mean	Median	SD
RET	12544	0.996	0.321	8.468	17391	1.145	0.330	8.888
LOGSIZE	11717	8.713	8.539	1.413	16184	8.540	8.455	1.158
BETA	11168	1.115	1.077	0.560	15199	0.737	0.748	0.786
AVG	11525	1.162	1.168	2.365	16034	1.307	1.298	2.427
TURN	12530	0.128	0.111	0.092	17129	0.130	0.110	0.093
BLEV	11988	0.428	0.397	0.230	17964	0.361	0.354	0.219
ROA	11880	4.243	4.561	5.192	17592	6.703	6.420	6.399
SALESGR	11964	5.016	4.112	16.247	17700	6.194	5.653	17.685
GPR	13440	98.490	91.240	30.023	20160	98.490	91.240	30.023
GPRAVG	13440	98.156	91.065	25.375	20160	98.156	91.065	25.375
US	13440	0.725	1.000	0.447	20160	0.725	1.000	0.447
WAR	13440	0.137	0.000	0.344	20160	0.137	0.000	0.344

Table 1 shows sample statistics for the total sample of firms, displaying defence firms and control firms separately. The presented sample statistics include the number of observations, mean, median and standard deviation for all variables. RET is the return in excess of the risk-free rate, LOGSIZE is the natural logarithm of market capitalisation, BETA is the time-varying beta based on the preceding 36 months of returns, AVG is the twelve-month average return, TURN is the share turnover, BLEV is the book leverage, ROA is the return on assets at the end of the preceding year, SALESGR is the yearly growth in sales at the end of the preceding year, GPR is the Geopolitical Risk Index, GPRAVG is the three-month average of GPR, US is a dummy equal to 1 if the firm is traded on a U.S. exchange and WAR is a dummy for the time period during the Russia-Ukraine war. The data consists of monthly data from January 2010 to December 2023.

3.2 Methodology

In order to examine the market performance of defence stocks, a pooled panel data regression approach is chosen. Previous research focusing on sin stocks uses primarily factor models and time-series regressions (e.g. Hong & Kacperczyk, 2009; Salaber, 2007 and 2009; Blitz & Fabozzi, 2017; Sagbakken & Zhang, 2021; Fabozzi, Ma & Oliphant, 2008). Some sin stock authors utilise cross-sectional regressions in addition to the time-series regressions (e.g. Hong & Kacperczyk, 2009; Sagbakken & Zhang, 2021) or just cross-sectional regressions alone (e.g. Borgers et al., 2015). Previous literature with a clear focus on the defence industry utilises other approaches than those used in the sin stock literature. Gurdgiev, Henrichsen & Mulhair (2022) use a panel data approach, which is deemed to be most suitable for the purposes of our study as well since both time- and cross-sectional variation are of interest. This approach is therefore favoured above an event study approach, which is commonly used in the defence stock literature.

Pooled panel data regression models estimated with OLS are used. This is favoured over random effects with GLS regressions, since the rejection of the null hypothesis of the Hausman test indicates that the individual effects are correlated with the explanatory variables. Using random effects models would thereby lead to biased estimators. Also, fixed effects models are not feasible given that the defence dummy variable and the U.S. dummy variable are time-invariant. The standard errors are robust to heteroscedasticity and autocorrelation.

Gurdgiev, Henrichsen & Mulhair (2022) focus only on dummy variables, and inspiration is therefore also taken from the cross-sectional regression model used by Hong and Kacperczyk (2009). Hong and Kacperczyk (2009) include a number of control variables, as well as a dummy variable indicating whether or not the stock in question is classified as a sin stock. Many of the control variables used by the authors can also be considered to account for similar aspects as those largely accounted for in factor models, such as size, value, momentum and market risk. Combining the approaches of the two studies, the simplest model specification used in our study is the following:

$$RET_{it} = \gamma_0 + \gamma_1 DEF_i + \boldsymbol{\gamma_k X_{it}} + \varepsilon_{it} \quad (1)$$

$\mathbf{X_{it}}$ is a vector consisting of the control variables $LOGSIZE_{it}$, $BETA_{it}$, $TURN_{it}$, AVG_{it}, $BLEV_{it}$, ROA_{it} and $SALESGR_{it}$. The choice of control variables, and the dependent variable RET_{it}, is primarily based on Hong and Kacperczyk (2009). Out of the control variables used by the authors, the variables $LOGSIZE_{it}$, $BETA_{it}$, $TURN_{it}$, AVG_{it} and $BLEV_{it}$ are included in our study. These are selected based on data availability. ROA_{it} and $SALESGR_{it}$ are not used by Hong and Kacperczyk (2009) but deemed relevant for this study and included as control variables. Both are added to adjust for the effects that changes in geopolitical risk could have on both revenue and profitability for defence firms, enabling the study to focus on the market sentiment towards defence firms. DEF_i is the defence dummy variable, and its coefficient can thereby indicate whether or not there is a difference in market performance between defence firms and control firms.

The model in Equation 1 is augmented by adding the variable GPR_t, resulting in the second model specification:

$$RET_{it} = \gamma_0 + \gamma_1 DEF_i + \gamma_2 GPR_t + \boldsymbol{\gamma_k X_{it}} + \varepsilon_{it} \quad (2)$$

GPR_t is, as previously described, the recent GPR Index by Caldara and Iacoviello (2022). The usage of a constructed index rather than more specific factors deviates from previous defence stock literature. However, it is in line with some literature investigating the effect of changes in geopolitical risk on financial asset performance more broadly (e.g. Umar et al., 2022; Będowska-Sójka, Demir and Zaremba, 2022). An advantage of using a geopolitical risk index is the possibility to account for an overall change in geopolitical risk rather than changes in specific aspects. Caldara and Iacoviello's (2022) recent GPR Index is chosen due to it being favoured as a proxy out of available indices for geopolitical risk in the covered previous geopolitical risk literature.

Equation 2 is then extended to a model including an interaction term between the defence dummy and the GPR Index:

$$RET_{it} = \gamma_0 + \gamma_1 DEF_i + \gamma_2 GPR_t + \gamma_3 DEF_i \times GPR_t + \boldsymbol{\gamma_k X_{it}} + \varepsilon_{it} \tag{3}$$

This interaction term is added to examine whether or not there is a difference in how defence stocks and control stocks are affected by geopolitical risk. Gurdgiev, Henrichsen and Mulhair (2022) describe that investors appear to use defence stocks to hedge against the adverse market reaction caused by a conflict announcement. That would suggest a potential difference in how defence stock performance is affected by changes in the level of geopolitical risk compared to control firms. Given the focus of this study, this variable is one of the variables that is of the most interest as it enables the study to investigate the effect of changes in geopolitical risk on defence firms.

Furthermore, to investigate if there is a difference between the U.S. market and the European markets in terms of defence stock performance, four additional variables are added to the model specified by Equation 3:

$$\begin{aligned} RET_{it} = \gamma_0 + \gamma_1 DEF_i + \gamma_2 GPR_t + \gamma_3 DEF_i \times GPR_t + \gamma_4 US_i + \gamma_5 DEF_i \times US_i \\ + \gamma_6 GPR_t \times US_i + \gamma_7 DEF_i \times GPR_t \times US_i + \boldsymbol{\gamma_k X_{it}} + \varepsilon_{it} \end{aligned} \tag{4}$$

US_i is the U.S. dummy variable. $DEF_i \times US_i$ is an interaction term between the defence dummy variable and the U.S. dummy variable. $GPR_t \times US_i$ is an interaction term between the GPR Index and the U.S. dummy variable. The coefficient for this variable could show potential differences between the U.S. and European markets in terms of the effect of changes in geopolitical risk.

It is therefore a variable of particular interest. $DEF_i \times GPR_t \times US_i$ is an interaction term between the defence dummy variable, the GPR Index and the U.S. dummy variable. The coefficient for this variable could be interpreted as the effect on return by geopolitical risk for U.S. defence firms, after adjusting for the previously mentioned variables, and is thereby another variable of particular interest in this study.

As a robustness check, GPR_t is replaced by the three-month average of the GPR Index, $GPRAVG_t$, in the regressions specified in Equations 2, 3 and 4. This is done to account for a potential lingering effect on the market sentiment of changes in geopolitical risk, and to see if the results still hold when this adjustment is done. Thereby, these will have the same specifications as the three equations they correspond to, with the exception of the GPR Index being replaced by its three-month average in all variables that it is involved in.

A different approach is also taken in terms of model specifications. This entails replacing GPR_t and all interaction terms involving this variable in Equations 2, 3 and 4 with the war dummy variable. This is done due to the observed difference in the utilised GPR Index before and after the start of the Russia-Ukraine war, which is illustrated in Figure 1. Furthermore, the large focus dedicated to this event in the geopolitical risk literature (e.g. Umar et al., 2022; Będowska-Sójka, Demir & Zaremba, 2022) indicates that this is an interesting event from a geopolitical risk perspective. The first out of these regression models is thereby specified as:

$$RET_{it} = \lambda_0 + \lambda_1 DEF_i + \lambda_2 WAR_t + \boldsymbol{\lambda_k X_{it}} + \varepsilon_{it} \tag{5}$$

and is thereby the war dummy counterpart to Equation 2. As a second model including the war dummy variable, the following specification is used:

$$RET_{it} = \lambda_0 + \lambda_1 DEF_i + \lambda_2 WAR_t + \lambda_3 DEF_i \times WAR_t + \boldsymbol{\lambda_k X_{it}} + \varepsilon_{it} \tag{6}$$

and this is hence the war dummy counterpart to Equation 3. The last out of these models is then specified as:

$$\begin{aligned} RET_{it} = \lambda_0 + \lambda_1 DEF_i + \lambda_2 WAR_t + \lambda_3 DEF_i \times WAR_t + \lambda_4 US_i + \lambda_5 DEF_i \times US_i \\ + \lambda_6 WAR_t \times US_i + \lambda_7 DEF_i \times WAR_t \times US_i + \boldsymbol{\lambda_k X_{it}} + \varepsilon_{it} \end{aligned} \tag{7}$$

which is the war dummy counterpart to Equation 4. The variables in these regressions are therefore to be interpreted in a similar way as their counterparts in Equations 2, 3 and 4.

4 Empirical Results

In this section, the results for the regressions specified in the previous section are presented. The results are also analysed in relation to previous literature and each other.

4.1 Results of GPR Index regressions

In Table 2 the results for the regression specified in Equations 1, 2, 3 and 4 are presented. These include the simplest model specification along with the three model specifications involving the GPR Index.

For the regression based on Equation 1, the coefficient for the defence dummy is significant and negative. This indicates that, after adjusting for control variables such as profitability, being a defence firm has a negative effect on returns. If defence stocks were to be considered sin stocks, these results would contradict the reasoning highlighted by Hong and Kacperczyk (2009) regarding the existence of a sin stock premium. In their study, the authors state that sin stocks should be relatively cheap due to investors neglecting them and the higher litigation risk, implying that there should be a so-called sin stock premium. Our results do not imply that there is such a premium for investing in defence stocks. Rather, they indicate that being a defence firm is negatively associated with returns. A potential reason for this is that defence stocks are not as largely considered unethical to invest in as the more traditional sin stocks. Many sin stock researchers either do not classify defence stocks as sinful at all (e.g. Hong & Kacperczyk, 2009; Salaber, 2007 and 2009) or only partially consider them to be sinful (Blitz and Fabozzi, 2017; Fabozzi, Ma & Oliphant, 2008; Borgers et al., 2015). The reasoning provided by Hong and Kacperczyk (2009) regarding sin stocks being neglected due to their sinfulness and therefore earning a premium should not be expected to hold for defence firms if defence itself is not considered sinful. Thereby, a positive coefficient for the defence dummy should not be expected either.

Table 2: Results for regressions based on Equations 1, 2, 3 and 4

	(1)	(2)	(3)	(4)
DEF	-0.411***	-0.418***	-2.131***	-3.357***
	(0.119)	(0.119)	(0.412)	(0.784)
GPR		-0.012***	-0.019***	-0.017***
		(0.002)	(0.003)	(0.005)
DEF_GPR			0.017***	0.030***
			(0.004)	(0.008)
US				1.798***
				(0.600)
DEF_US				1.666*
				(0.918)
GPR_US				-0.004
				(0.006)
DEF_GPR_US				-0.018**
				(0.009)
LOGSIZE	0.226***	0.244***	0.242***	0.296***
	(0.047)	(0.047)	(0.047)	(0.048)
BETA	0.277***	0.259***	0.259***	0.316***
	(0.090)	(0.090)	(0.090)	(0.091)
AVG	-0.176***	-0.186***	-0.194***	-0.221***
	(0.028)	(0.028)	(0.028)	(0.028)
TURN	-4.776***	-4.826***	-4.826***	-8.244***
	(0.876)	(0.876)	(0.875)	(1.031)
BLEV	-0.251	-0.211	-0.213	-0.253
	(0.304)	(0.304)	(0.304)	(0.303)
ROA	-0.014	-0.014	-0.013	-0.035***
	(0.012)	(0.012)	(0.012)	(0.013)
SALESGR	-0.003	0.000	0.000	0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Intercept	0.169	1.197***	1.939***	0.815
	(0.411)	(0.450)	(0.484)	(0.661)
R^2	0.005	0.007	0.008	0.012

Table 2 shows the regression results for the models specified by Equations 1, 2, 3 and 4 applied to the stock sample of 80 defence firms and 120 control firms in the U.S. and European markets. The dependent variable is return in excess of the risk-free rate. DEF (the defence dummy), GPR (the geopolitical risk index), DEF_GPR (the interaction term between the defence dummy and the geopolitical risk index), US (the U.S. market dummy), DEF_US (the interaction term between the defence dummy and the U.S. market dummy), GPR_US (the interaction term between the geopolitical risk index and the U.S. market dummy) and DEF_GPR_US (the interaction term between the defence dummy, the geopolitical risk index and the U.S. market dummy) are the variables of interest. LOGSIZE (the natural logarithm of market capitalization), BETA (the time-varying beta based on the preceding 36 months of returns), AVG (the twelve-month average return), TURN (the share turnover), BLEV (the book leverage), ROA (the return on assets) and SALESGR (the sales growth) are the control variables which are included in each of the regressions. Intercept is the intercept of the regressions. Monthly data beginning in January 2010 and ending in December 2023 is used. Significance at the 10%, 5% and 1% level, meaning the p-value is below the respective values, is indicated by "", "**" and "***", respectively. Standard errors of the coefficients are presented below the coefficients in brackets.*

The regression based on Equation 2 includes the GPR Index as well. For the defence dummy, the coefficient remains negative and significant. The coefficient for the GPR Index is also negative and significant, suggesting that geopolitical risk affects stock returns for the sample firms negatively. This aligns with the findings by Będowska-Sójka, Demir and Zaremba (2022), Rigobon and Sack (2005) and Amihud and Wohl (2004), all of which find that increased geopolitical risk, or increases in factors that increase geopolitical risk, has a negative effect on equity prices at large. However, this effect is small, with a one unit increase in the GPR Index yielding a 0.012 percentage point decrease in returns. Furthermore, since the majority of the sample firms are control firms and not defence firms, this result does not indicate that the same negative effect is observed for defence firms alone.

As for the regression based on Equation 3, the coefficients for the defence dummy and the GPR Index remain negative and significant. However, the coefficient for the defence dummy becomes a little more than five times larger in absolute terms, further implying a worse general performance by defence stocks than the control stocks. The coefficient for the added interaction term is significant and positive. The total effect of increased geopolitical risk on defence stocks is however still negative, as the sum of the coefficient for the GPR Index and the interaction term is -0.002. This effect is smaller in absolute terms than the negative effect of geopolitical risk on the control firms, as the effect of geopolitical risk on control firms is only the one indicated by the coefficient for the GPR Index. The results thereby indicate that defence stocks perform better than control firms during periods of high geopolitical risk. These results partially align with the findings of Shapiro, Switzer and Mastroianni (2011) and Gurdgiev, Henrichsen and Mulhair (2022). Since defence stocks appear to be less sensitive to changes in geopolitical risk than control stocks, the results indicate that defence stocks could potentially be used as a hedge during periods of increased tensions. This aligns with the findings by Gurdgiev, Henrichsen and Mulhair (2022). However, given that the effect of geopolitical risk is rather small for both defence and control firms, there may be other securities that are more suitable hedges for geopolitical risk.

The results for the regression specified by Equation 4 show that the coefficients for the defence dummy, the GPR Index and the interaction term between the two remain significant and with the same respective signs as in the previous regressions. Compared to the coefficients for these three variables in Equation 3, differences are observed in terms of magnitude. This is particularly the case for the coefficient for the defence dummy, which becomes larger in absolute terms. For the U.S. dummy, the coefficient is positive and significant, indicating that American stocks in the sample tend to outperform European stocks. Furthermore, the interaction term between the U.S. dummy and the defence dummy is significant and positive, which can be interpreted as that the trait of being an American defence stock is positively associated with returns. In terms of interpreting the effect of geopolitical risk on U.S. and European defence firms, respectively, the derivative can be taken of Equation 4 with respect to the GPR Index to see the marginal effect of the index on the dependent variable. It then results in the following derivatives for European and U.S. defence firms, respectively:

$$\frac{\partial RET_{it}}{\partial GPR_t} = \gamma_2 + \gamma_3 DEF_i + \gamma_6 US_i + \gamma_7 DEF_i \times US_i = \begin{cases} if\ DEF = 1\ and\ US = 0:\ \gamma_2 + \gamma_3 \\ if\ DEF = 1\ and\ US = 1:\ \gamma_2 + \gamma_3 + \gamma_6 + \gamma_7 \end{cases} \quad (8)$$

The coefficient for the interaction term between the defence dummy and the GPR Index, γ_3, is in this regression larger than the coefficient for the GPR Index, γ_2. The sum of these two coefficients is thereby positive, which indicates a positive total effect of increases in geopolitical risk on European defence stock returns. Still, the effect is rather small, merely a 0.013 percentage point increase in return per unit of increase in the GPR Index. For American defence stocks, the total effect of changes in geopolitical risk also includes the coefficient for the interaction term between the GPR Index and the U.S. dummy, γ_6, and the coefficient for the triple interaction term, γ_7. However, the coefficient for the interaction between the GPR Index and the U.S. dummy is not significant. The coefficient for the triple interaction term is significant and negative. Adding the effect of the triple interaction term to the previously mentioned sum results in a negative number, -0.005. This indicates that the returns of U.S. defence stocks are negatively affected by increased geopolitical risk, and the reasoning presented in the previous paragraph regarding defence stocks potentially being used as a hedge thereby mainly seems to be valid for European firms. U.S. defence stocks are still less negatively affected by increased geopolitical risk than control firms, for which the effect is solely that of γ_2. Thereby, the U.S. defence stocks display less sensitivity to changes in geopolitical risk than the control firms. The main event discussed in this study, the start of the Russia-Ukraine war, causes the largest change in the GPR Index during the studied period. Due to one of the studied areas' proximity to the war, differences between the markets could perhaps be considered expected.

To conclude, the results are largely in line with previous literature. Firstly, there does not seem to be a premium for investing in defence stocks, and thereby there is no observable equivalent to a sin stock premium. This could spur from investors not considering defence firms as unethical to the same extent as more traditional sin stocks. Therefore, the rationale behind the existence of a sin stock premium does not hold for these firms. This is further indicated by the large exclusion of defence stocks in the sin stock literature. Secondly, geopolitical risk seems to have a negative relationship with stock returns at large, as showed by previous literature as well. Thirdly, defence stock returns seem to be less negatively affected by increases in geopolitical risk, indicating that they may serve as a hedge against increases in geopolitical risk to some extent. This is also argued by some previous literature, but as the effect that we find is rather small, other securities may be more suitable hedges. Lastly, when accounting for differences between the U.S. and Europe, the European defence firms seem to be positively affected by increases in geopolitical risk, whereas American defence firms only are less negatively affected compared to the control firms. This could be considered expected given that the main event affecting geopolitical risk during the studied period, the Russia-Ukraine war, is taking place within Europe. Although the effect of geopolitical risk on defence stock returns overall appears to be small, large changes in geopolitical risk could yield a considerable effect on defence stock returns. This indicates that important geopolitical events resulting in large increases of the GPR Index may have a substantial effect on defence stock returns.

4.2 Robustness checks using a three-month average of the GPR Index

The results for the robustness checks of the regressions based on Equations 2, 3 and 4 are presented in Table 3 together with the results for the regression based on Equation 1, the most simple specification. These regressions use, as described in section *3.2 Methodology*, a three-month average of the GPR Index instead of the GPR Index in all variables that the GPR Index is involved in.

Table 3: Results for regression 1 and robustness checks for regressions 2, 3 and 4

	(1)	(2)	(3)	(4)
DEF	-0.411***	-0.421***	-1.518***	-2.571***
	(0.119)	(0.119)	(0.471)	(0.895)
GPRAVG		-0.019***	-0.024***	-0.018***
		(0.002)	(0.003)	(0.006)
DEF_GPRAVG			0.011**	0.022**
			(0.005)	(0.009)
US				2.266***
				(0.713)
DEF_US				1.454
				(1.048)
GPRAVG_US				-0.009
				(0.007)
DEF_GPRAVG_US				-0.016
				(0.010)
LOGSIZE	0.226***	0.253***	0.252***	0.308***
	(0.047)	(0.047)	(0.047)	(0.048)
BETA	0.277***	0.248***	0.248***	0.304***
	(0.090)	(0.090)	(0.090)	(0.091)
AVG	-0.176***	-0.198***	-0.202***	-0.231***
	(0.028)	(0.028)	(0.028)	(0.028)
TURN	-4.776***	-4.853***	-4.843***	-8.294***
	(0.876)	(0.874)	(0.874)	(1.030)
BLEV	-0.251	-0.190	-0.193	-0.228
	(0.304)	(0.304)	(0.304)	(0.303)
ROA	-0.014	-0.014	-0.013	-0.036***
	(0.012)	(0.012)	(0.012)	(0.012)
SALESGR	-0.003	0.001	0.001	0.002
	(0.004)	(0.004)	(0.004)	(0.004)
Intercept	0.169	1.818***	2.289***	0.831
	(0.411)	(0.461)	(0.506)	(0.749)
R^2	0.005	0.008	0.009	0.012

Table 3 shows the regression results for the models specified by Equation 1 and the robustness checks of the regressions specified by Equations 2, 3 and 4 applied to the stock sample of 80 defence firms and 120 control firms in the U.S. and European markets. The dependent variable is return in excess of the risk-free rate. DEF (the defence dummy), GPRAVG (the three-month average of the geopolitical risk index), DEF_GPRAVG (the interaction term between the defence dummy and the three-month average of the geopolitical risk index), US (the U.S. market dummy), DEF_US (the interaction term between the defence dummy and the U.S. market dummy), GPRAVG_US (the interaction term between the three-month average of the geopolitical risk index and the U.S. market dummy) and DEF_GPRAVG_US (the interaction term between the defence dummy, the three-month average of the geopolitical risk index and the U.S. market dummy) are the variables of interest. LOGSIZE (the natural logarithm of market capitalization), BETA (the time-varying beta based on the preceding 36 months of returns), AVG (the twelve-month average return), TURN (the share turnover), BLEV (the book leverage), ROA (the return on assets) and SALESGR (the sales growth) are the control variables which are included in each of the regressions. Intercept is the intercept of the regressions. Monthly data beginning in January 2010 and ending in December 2023 is used. Significance at the 10%, 5% and 1% level, meaning the p-value is below the respective values, is indicated by "", "**" and "***", respectively. Standard errors of the coefficients are presented below the coefficients in brackets.*

The results are rather similar to those presented for the regressions based on Equations 2, 3 and 4. The coefficients for the control variables are of similar magnitude and significance and the signs remain the same. For Equation 2, the robustness check yields very similar coefficients for both the defence dummy and for the calculated average of the GPR Index, indicating robust results. The coefficients for the robustness check for Equation 3 are also similar to those of the original specification, with the main difference being that the coefficient for the defence dummy is smaller in absolute terms, although still negative and highly significant. Furthermore, the coefficient for the interaction term is slightly smaller and only significant at the five percent level and not the one percent level. The robustness check for Equation 4 also yields similar results, with some differences in magnitude and significance. The most notable ones are that the robustness check displays a smaller coefficient for the defence dummy in absolute terms, a larger coefficient for the U.S. dummy, that the interaction term between these two dummies is no longer significant and that the triple interaction term is no longer significant. Overall, the checks appear to indicate robust results, with the exception of the previously discussed differences between the U.S. and European markets.

4.3 Results of war dummy regressions

Lastly, the results for the regressions using the war dummy instead of the GPR Index are presented in Table 4. These involve the results for the regressions specified by Equations 5, 6 and 7, which are presented together with the results for the most simple model specification involving just the defence dummy, which is described by Equation 1.

The coefficients presented in Table 4 for Equation 5 have the same signs and are of similar magnitude as those presented in Table 2 for Equation 2, with the exception of the war dummy compared to its counterpart in Equation 2, the GPR Index. Furthermore, the same coefficients are significant in the two different models, with the same exception. The coefficient for the war dummy is non-significant as opposed to the coefficient for the GPR Index in Equation 2. The coefficients of the two variables have the same sign however, as both are negative. The negative sign of the coefficient of the war dummy may indicate that the sample stocks perform worse after the start of the Russia-Ukraine war, and thereby during the period of an elevated general level of geopolitical risk. This would imply that the start of the war affects stock returns negatively, which would be in line with the findings of Będowska-Sójka, Demir and Zaremba (2022), Rigobon and Sack (2005) and Amihud and Wohl (2004). However, the coefficient is not significant, and our results thereby do not provide similar evidence to that provided by previous literature regarding the effect of war on stock returns more broadly.

As for the regression based on Equation 6, all coefficients have the same sign as in the results for the regression based on Equation 3, with the exception of one control variable. The coefficients for the control variables are of similar magnitude, but the results for the variables of interest differ slightly. Although the coefficients for the defence dummy, the war dummy and the interaction term have the same signs as their counterparts in Equation 3, the coefficient for the defence dummy is of much smaller magnitude. However, it is still significant and negative. Furthermore, the coefficient for the war dummy is, as opposed to that of the GPR Index in Equation 3, non-significant. Lastly, the coefficient for the interaction term between the defence dummy and the war dummy has the same sign as that for the interaction term between the defence dummy and the GPR Index, but is non-significant. It is thereby not clear from these results whether or not there is a difference between defence stock market performance and the market performance of the control firms after the start of the Russia-Ukraine war. These results thereby do not clearly indicate a difference in performance for defence firms nor control firms during the period of an elevated level of geopolitical risk.

The coefficients presented for Equation 7 all have the same signs as their counterparts in Equation 4, except for the coefficient of one control variable. However, there are some differences in magnitude and regarding significance. The coefficient for the defence dummy is smaller in absolute terms, but still negative and significant, further indicating a worse market performance for defence firms than control firms. As opposed to the coefficient for the GPR Index in Equation 4, the coefficient for the war dummy is non-significant. The coefficient for the U.S. dummy is of similar magnitude and significant. The coefficient for the interaction term between the defence dummy and war dummy is larger than its counterpart in Equation 4, but only significant at the five percent level. However, when comparing the coefficient to the coefficient of the same interaction term in the simpler model specification, Equation 6, it is of larger magnitude and has gained significance. The sign of the coefficient is positive, indicating that defence firms perform better after the outbreak of the Russia-Ukraine war. However, the coefficient of the triple interaction term is significant and negative, and the magnitude of the coefficient undoes the positive association between the period after the start of the war and the stock market performance of American defence firms. It thereby seems like only European defence firms tend to perform better after the event, whereas American defence firms do not.

Table 4: Results for regressions based on Equations 1, 5, 6 and 7

	(1)	(5)	(6)	(7)
DEF	-0.411***	-0.416***	-0.470***	-0.593***
	(0.119)	(0.119)	(0.123)	(0.225)
WAR		-0.183	-0.355	-0.183
		(0.179)	(0.238)	(0.450)
DEF_WAR			0.415	1.377**
			(0.354)	(0.664)
US				1.422***
				(0.197)
DEF_US				0.086
				(0.264)
WAR_US				-0.339
				(0.524)
DEF_WAR_US				-1.390*
				(0.783)
LOGSIZE	0.226***	0.232***	0.231***	0.287***
	(0.047)	(0.047)	(0.047)	(0.048)
BETA	0.277***	0.277***	0.269***	0.328***
	(0.090)	(0.090)	(0.091)	(0.091)
AVG	-0.176***	-0.178***	-0.179***	-0.208***
	(0.028)	(0.028)	(0.028)	(0.028)
TURN	-4.776***	-4.800***	-4.791***	-8.159***
	(0.876)	(0.877)	(0.877)	(1.035)
BLEV	-0.251	-0.238	-0.238	-0.264
	(0.304)	(0.304)	(0.304)	(0.303)
ROA	-0.014	-0.014	-0.014	-0.036***
	(0.012)	(0.012)	(0.012)	(0.013)
SALESGR	-0.003	-0.002	-0.002	-0.001
	(0.004)	(0.004)	(0.004)	(0.004)
Intercept	0.169	0.147	0.180	-0.740*
	(0.411)	(0.412)	(0.412)	(0.450)
R^2	0.005	0.005	0.006	0.009

Table 4 shows the regression results for the models specified by Equations 1, 5, 6 and 7 applied to the stock sample of 80 defence firms and 120 control firms in the U.S. and European markets. The dependent variable is return in excess of the risk-free rate. DEF (the defence dummy), WAR (the Russia-Ukraine war dummy), DEF_WAR (the interaction term between the defence dummy and the Russia-Ukraine war dummy), US (the U.S. market dummy), DEF_US (the interaction term between the defence dummy and the U.S. market dummy), WAR_US (the interaction term between the Russia-Ukraine war dummy and the U.S. market dummy) and DEF_WAR_US (the interaction term between the defence dummy, the Russia-Ukraine war dummy and the U.S. market dummy) are the variables of interest. LOGSIZE (the natural logarithm of market capitalization), BETA (the time-varying beta based on the preceding 36 months of returns), AVG (the twelve-month average return), TURN (the share turnover), BLEV (the book leverage), ROA (the return on assets) and SALESGR (the sales growth) are the control variables which are included in each of the regressions. Intercept is the intercept of the regressions. Monthly data beginning in January 2010 and ending in December 2023 is used. Significance at the 10%, 5% and 1% level, meaning the p-value is below the respective values, is indicated by "", "**" and "***", respectively. Standard errors of the coefficients are presented below the coefficients in brackets.*

In summary, utilising a war dummy instead of the GPR Index yields similar results, but does not achieve the same level of significance for the variables of interest. This could be explained by the fact that, unlike the war dummy, the GPR Index is non-binary and is therefore able to incorporate more events affecting geopolitical risk. Despite this, the results again show that the defence firms seem to perform worse than the control firms. Furthermore, defence firms appear to be positively affected by the event of war. The effect is however only observed for European defence firms, whereas American defence firms do not display the same effect. This indicates that only European firms perform better during the period of an elevated level of geopolitical risk. The difference between the markets could be related to the fact that the war that the war dummy is based on is taking place within Europe's borders.

5 Conclusion

This study aims to analyse defence stock market performance with a particular focus on geopolitical risk. There have been indications of a potential change in market sentiment towards defence firms in conjunction with changes in the level of geopolitical risk, making this a relevant topic. As the U.S. and European markets are the most widely studied in previous literature, the choice to study to these markets allows for comparison with previous literature. It also allows for comparison between the markets in terms of investor attitude towards defence firms.

Using pooled panel data regression models estimated with OLS and including several control variables, different dummy variables and a geopolitical risk index, the study does not find a premium for investing in defence firms over the studied period of January 2010 until December 2023. Rather, defence firms display worse market performance than control firms. These results are interpreted in the light of defence stocks possibly not being viewed as unethical and a sin stock premium thereby not being expected, which aligns with the choice of many authors in the sin stock literature to exclude the defence industry from their sin industries. Furthermore, geopolitical risk is found to have a negative impact on stock returns more broadly, but a less negative effect or even a positive effect on the returns of defence stocks. This also aligns with previous literature, where defence stocks are argued to be suitable as a hedge against increases in geopolitical risk. However, as the effect is rather small, there may be other securities which would serve as a more suitable hedge.

When investigating potential differences between the U.S. and European markets, it is found that the observed effects for the defence firms in the sample are mainly valid for European firms. The market performance of European defence stocks is positively affected by increases in geopolitical risk and the event of war, whereas the American ones' is not. American defence firms, compared to control firms, only display a less negative effect on stock returns by increases in geopolitical risk. However, the effect on returns is relatively small, indicating that relatively large increases or decreases in geopolitical risk would be necessary for a substantial effect on returns to be observed. The differences between the results for the U.S. and European markets may be related to the fact that the event having the largest impact on geopolitical risk over the studied period, the start of the Russia-Ukraine war, takes place within Europe's borders.

Thereby, there seems to be a relationship between defence firms' stock returns and geopolitical risk which is different from that of control firms' stock returns and geopolitical risk. There are differences between the two studied geographic areas, but the results overall indicate that defence firms are less adversely affected by increased geopolitical risk than control firms. These findings confirm the findings of previous studies and bring a new perspective on the market performance of defence stocks.

Further research can put an emphasis on the difference between the traditional sin stocks and defence stocks in terms of market performance, since the view on defence firms seems to have shifted whereas the view on other sin industries perhaps has not. Furthermore, studies of other markets than those being the focal point in this study could also be interesting. These are not as extensively explored in previous literature, and potential differences in investor behaviour and sentiment towards defence could yield different results for these markets.

References

Ainger, J., & Arons, S. (2022). Weapons Group Points to Ukraine in Bid to Shape ESG Rulebook (1), *Bloomberg*, 28 February, Available online: https://blinks.bloomberg.com/news/stories/R80IX2DWRGG4 [Accessed 4 April 2024]

Amihud, Y., & Wohl, A. (2004). Political News and Stock Prices: The case of Saddam Hussein contracts, *Journal of Banking & Finance*, vol. 28, no. 5, May 2004, pp. 1185-1200, Available online: https://www.sciencedirect.com/science/article/pii/S0378426603002097?via%3Dihub [Accessed 23 April 2024]

Będowska-Sójka, B., Demir, E., & Zaremba, A. (2022). Hedging Geopolitical Risks with Different Asset Classes: A focus on the Russian invasion of Ukraine, *Finance Research Letters*, vol. 50, December 2022, 103192, Available online: https://www.sciencedirect.com/science/article/pii/S1544612322003981?pes=vor [Accessed 23 April 2024]

Blitz, D., & Fabozzi, F.J. (2017). Sin Stocks Revisited: Resolving the sin stock anomaly, *The Journal of Portfolio Management*, vol. 44, no. 1, Fall 2017, pp.105-111, Available online: https://www.pm-research.com/content/iijpormgmt/44/1/105 [Accessed 25 March 2024]

Borgers, A., Derwall, J., Koedijk, K., & Ter Horst, J. (2015). Do Social Factors Influence Investment Behavior and Performance? Evidence from mutual fund holdings, *Journal of Banking & Finance*, vol. 60, November 2015, pp.112-126, Available online: https://www.sciencedirect.com/science/article/pii/S0378426615001831?via%3Dihub [Accessed 27 March 2024]

Caldara, D., & Iacoviello, M. (2022). Measuring Geopolitical Risk, *American Economic Review*, vol. 112, no. 4, April 2022, pp.1194-1225, Available online: https://www.matteoiacoviello.com/gpr_files/GPR_PAPER.pdf [Accessed 15 April 2024]

Capelle-Blancard, G., & Couderc, N. (2008). What Drives the Market Value of Firms in the Defense Industry?, *Review of Financial Economics*, vol. 17, no. 1, pp.14-32, Available online: https://onlinelibrary.wiley.com/doi/10.1016/j.rfe.2007.02.001 [Accessed 27 March 2024]

Causevic, A., Beslik, S., & Causevic, S. (2022). Quo Vadis Sustainable Finance: Why defensive weapons should never be classified as an ESG investment, *Journal of Sustainable Finance and Investment*, pp. 1-9, Available online: https://www.tandfonline.com/doi/full/10.1080/20430795.2022.2135965 [Accessed 29 March 2024]

DefenseNews (2024). Top 100 Defense Companies, Available online: https://people.defensenews.com/top-100// [Accessed 15 April 2024]

Fabozzi, F.J., Ma, K.C., & Oliphant, B.J. (2008). Sin Stock Returns, *The Journal of Portfolio Management*, vol. 35, no. 1, Fall 2008, pp.82-94, Available online: https://www.pm-research.com/content/iijpormgmt/35/1/82 [Accessed 25 March 2024]

Fama, E.F., & French, K.R. (1997). Industry Cost of Equity, *Journal of Financial Economics*, vol. 43, no. 2, February 1997, pp.153-193, Available online: https://www.sciencedirect.com/science/article/pii/S0304405X96008963?via%3Dihub [Accessed 10 April 2024]

Geopolitical Risk (GPR) Index. (2024). GPR Index, Available online: https://www.matteoiacoviello.com/gpr.htm [Accessed 23 April 2024], Licence for the web page: https://creativecommons.org/licenses/by/4.0/, Web page maintained by Wells, L., Yang, W., Yu, D., & Iacoviello, M.

Gurdgiev, C., Henrichsen, A., & Mulhair, A. (2022). The Budgets of Wars: Analysis of the U.S. defense stocks in the Post-Cold War era, *International Review of Economics & Finance*, vol. 82, November 2022, pp.335-346, Available online: https://www.sciencedirect.com/science/article/pii/S1059056022001836 [Accessed 1 April 2024]

Hong, H., & Kacperczyk, M. (2009). The Price of Sin: The effects of social norms on markets, *Journal of Financial Economics*, vol. 93, no. 1, July 2009, pp.15-36, Available online: https://www.sciencedirect.com/science/article/pii/S0304405X09000634?via%3Dihub [Accessed 9 February 2024]

Rigobon, R., & Sack, B. (2005). The Effects of War Risk on US Financial Markets, *Journal of Banking & Finance*, vol. 29, no. 7, July 2005, pp. 1769-1789, Available online: https://www.sciencedirect.com/science/article/pii/S0378426604002377?via%3Dihub [Accessed 23 April 2024]

Sagbakken, S.T., & Zhang, D. (2021). European Sin Stocks, *Journal of Asset Management*, vol. 23, no. 1, November 2021, pp.1-18, Available online: https://link.springer.com/article/10.1057/s41260-021-00247-9 [Accessed 25 March 2024]

Salaber, J. (2007). The Determinants of Sin Stock Returns: Evidence on the European market, preprint, Available online: https://shs.hal.science/halshs-00170219/document [Accessed 27 March 2024]

Salaber, J. (2009). Sin Stock Returns over the Business Cycle, Available online: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1443188 [Accessed 25 March 2024]

Shapiro, D.M., Switzer, L.N., & Mastroianni, D.P.N. (2011). War and Peace: The reaction of defense stocks, *The Journal of Applied Business Research*, vol. 15, no. 3, pp.21-36, Available online: https://clutejournals.com/index.php/JABR/article/view/5668/5745 [Accessed 23 April 2024]

Skandinaviska Enskilda Banken AB. (2022). SEB Investment Management Updates the Sustainability Policy for Investments in the Defence Industry, Available online: https://sebgroup.lu/private/our-funds/information-for-investors/news/2022/seb-investment-management-updates-the-sustainability-policy-for-investments-in-the-defence-industry [Accessed 4 April 2024]

Solomon, E. (2022). Germany Does '180-degree turn' in Defence Policy Following Russian Aggression, *Financial Times*, 27 February, Available online: https://www.ft.com/content/ab3857f4-666f-45c9-b191-be5aa5abcb41 [Accessed 15 April 2024]

Statista. (2024). Total Bilateral Aid Commitments to Ukraine Between January 24, 2022 and January 15, 2024, by donor and type, Available online: https://www.statista.com/statistics/1303432/total-bilateral-aid-to-ukraine/ [Accessed 1 April 2024]

S&P Global. (2024). Top Geopolitical Risks of 2024, Available online: https://www.spglobal.com/en/enterprise/geopolitical-risk/ [Accessed 22 April 2024]

Taylor, A. (2024). What to Know About U.S. Military Aid to Israel, *The Washington Post*, 2 April, Available online: https://www.washingtonpost.com/world/2024/04/02/us-military-aid-israel-gaza-biden/ [Accessed 4 April 2024]

Umar, Z., Bossman, A., Choi, S., & Teplova, T. (2022). Does Geopolitical Risk Matter for Global Asset Returns? Evidence from quantile-on-quantile regression, *Finance Research Letters*, vol. 48, August 2022, 102991, Available online: https://www.sciencedirect.com/science/article/pii/S1544612322002392?via%3Dihub [Accessed 23 April 2024]