Impact of Russia-Ukraine war on US stock returns: A comparative analysis of High and Low ESG companies

Dissertation submitted

by

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to

Department of Economics,
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in partial fulfilment of the requirements for the degree of

Master in Monetary and Financial Economics

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27/05/2024

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Abstract:

The thesis explores the connection between the ESG (Environmental Social Governance) score and abnormal returns during a recent geopolitical crisis, the Russian invasion of Ukraine. The purpose is to investigate whether the US firms that hold high ESG scores are impacted differentially compared to those with lower scores. Furthermore, the work will explore how the stocks of high and low ESG companies have fluctuated in the months pre and post the invasion date. The results reveal that two months before the war, the abnormal stock returns of low ESG firms began to surpass those of companies associated with high ESG. However, this effect diminished as the official beginning of the war approached.

Key words: ESG, Russia-Ukraine, war, abnormal returns, threshold model

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Table of contents

Introduction

Background

The Russo-Ukrainian conflict began in early 2014 following by various naval incidents, cyberwarfare and political tensions. The continuous Russia-Ukraine conflict took an increased turn in 2022 causing a significant impact on the global markets that completely change the investing space (Alam et al., 2002). A major part of this rethink surrounds the importance of Environmental, Social and Governance (ESG) criteria in choosing investments.

Over the past decade, ESG investing has gained significant traction on prioritizing companies based on their environmental impact, social responsibility and governance practices. According to Global Sustainable Investment Alliance (2021), by 2022, ESG assets were expected to exceed $53 trillion which represents more than one third of the forecasted total global assets under management. The intersection of ESG investing and geopolitical conflicts presents a unique challenge: the ethically challenging nature of investing in defense firms that are at times associated with lower ESG ratings, especially during wars.

The defense sector has been singled out during the Russia-Ukraine conflict, where traditionally this domain suffers from lower ESG scores owing to its operational aspect (Puaschunder, 2019). These debates on the ethical aspects of investments in defense have been stirred up by the war; some claim that such investments are required for national security purposes, while others argue against it citing them as being antithetical to the principles of socially responsible investing (SRI) (Lewis and Juravle, 2010).

Consequently, it becomes important to understand how high and low ESG stocks behave in such conflicts for the case of this complex scenario. Initial research indicates that market reactions to geopolitical risks are quite different for companies with high ESG rating and those with low, with some sectors, such as defense, even attracting more interest from investors (Grewal et al., 2019). This thesis aims to deepen this phenomenon by examining the excess returns of high vs low ESG scored companies before and during the Russia-Ukraine war, thus questioning conventional wisdom of ESG investing.

Investigation & objectives:

The research intends to search in more detail whether the war impacted differently the firms in the US with high and low ESG rating and how their abnormal returns are moving in the escalation of the conflict.

The main objective is to assess whether the returns of high and low ESG companies outperform the market a couple of months before and after the war. Moreover, a comparison of the two groups of companies distinguished by their ESG score will be made to assess which group handle the crisis more successfully.

Stock prices reflect investors demand and their expectations regarding future performance and risks, especially in markets described by high volatility (Chen et al., 2022). Following that notion, the thesis provides insights of weather investors prioritize profit at the expense of environmental, social and governance benefits. Profit maximization was widely considered as the primary objective of investors. However, recent studies such the one conducted by (Alvarez and Lunde, 2023) challenges that established theory.

In essence, this study seeks to deepen the understanding of the impact of geopolitical conflicts on ESG stock returns by focusing on the ongoing war between Russia and Ukraine. Hereby, it contributes insights for sustainable finance and investment in general.

The central question can be articulated as: Do high or low oriented firms perform better during the Russia-Ukraine war?

Significance:

This is an important question given recent evidence of a rise in investor demand for defense stocks – usually having lower ESG scores – after the initiation of the war (Caldara and Iacoviello, 2022). This contradicts the prior research, implying that it would offer a reason as to why higher ESG ratings are not always associated with better stock performance (Paradis and Schiehll, 2021). The Russia-Ukraine war is a distinctive repository to discern this correlation since it has critically fashioned international market perceptions including network of supply chains and costs of energy (Ratten, 2023).

In addition, it is noteworthy to mention that the importance of this question can be found in its ability to add up to the discussion on ESG investing strategies strength under geopolitical instability context. ESG investing is praised for its emphasis on long-term value and moral undertones (Miralles-Quirós and Miralles-Quirós, 2021). However, it faces unresolved questions about its ability to perform during acute crises. As such, this research will explore the possibility of traditional ESG investment strategies accommodating to changes that arise from these conflicts.

More so, this study will shed light into investor's behaviour during which investors are interested in short-run performance rather than long-run sustainability or ethical considerations even in times of crisis. This has major implications for the sustainable ESG investing in periods of market volatility and also to ethics investment strategies (Atkins et al., 2023).

Methodology & contribution:

The methodology is a combination of multiple regression models with dummy variables and fixed-effects-panel-threshold-models. Initially, I employed the fixed-effect-panel-threshold model as outlined by (Wang, 2015) to find the optimal threshold of ESG rating at which the relationship between ESG scores and stock returns diverges. The threshold value was data-driven providing a reliable indication of its significance. Subsequently, the threshold was utilized to separate companies in the dataset into groups with high and low ESG. The study incorporates a regression model with returns as the dependent variable. Adapting from Le et al. (2022) the model includes independent dummy variables to capture the impact of the progression of the Russia-Ukraine war over time on returns. Market returns proxied by S&P500 index were added to analyze the abnormal returns, based on various researches (Le et al., 2022).

The thesis contributes to the previous literature by numerous ways. There is limited literature associating wars with ESG scores, that are becoming a pivotal instrument for financial investing. The majority of them focused on the EU stock market and concluding that investing in high ESG during such crises is not the best strategy. This study is concentrated on the U.S. market, which, although geographically far from the war, is still affected by it. Due to the global interconnectedness of modern economies, markets in segments other than those directly involved will be impacted, especially a major global player such as the U.S.

Another vital contribution of that thesis is the fixed-effect-panel-threshold model approach used to estimate the most appropriate threshold to separate high ESG firms from low. In the previous literature the most common approach did not group firms according to their ESG score, assuming a linear relationship between ESG ratings and returns (Kick and Rottmann, 2022). Alvarez and Lunde (2023) in their master's thesis, separate groups into average and above-average ESG, based on standard categories established by the agency that provides the scores. Another methodology was dividing the companies into the highest and lowest quintiles based on their ESG scores (Aybars and Zehir, 2020). Thereby, the high ESG group consists of the companies in the top 20% and the low ESG group include the bottom 20%.

The extended study period in relation to the existing literature can be considered a valuable contribution. The thesis collected data up to June 2023 which is about a year more than the period studied in related literature before (Alvarez and Lunde, 2023). Therefore, the thesis might either enhance the robustness of previous findings or challenge them. The time period investigated by Kick and Rottmann (2022) was from January 2015 up to a week after the war. The period under study is long to provide significant results about how the event of the invasion impacted the relationship between ESG and stock returns. January 2015 was the starting point of the investigation by Huq et al., (2022) with October 2022 to be the last month included in the research. The present study extends the timeframe in the opposite direction, up to mid-2023. In the context of ongoing events like the Russia-Ukraine war, that could reveal new patters as economic impacts evolve over time.

A regression model observing the returns monthly, starting from 3 months before the initiation of the war until 1 months after, hasn't been implemented before. This methodology adds to previous research by providing more comprehensive results specific to each month, in contrast to more general findings regarding the average ESG impact on returns throughout the study period (Xiao et al., 2023).

Outline:

The thesis is structured as follows:

Chapter 2 discuss previous investigations and their results. It includes researches studying ESG scores and stock returns relationship, war impact on stock returns and ESG impact on returns during wars. In that chapter the theoretical background of the thesis will be analyzed and evidence coming from the literature will be presented to support the skeptic behind the hypothesis formation.

Chapter 3 describe the methodology of the empirical analysis. The regression models will be introduced along with the data collected. The descriptive statistics and empirical results obtained from statistical and regression analyses, will be reported.

Chapter 4 discuss the assumptions and the limitations of the thesis.

Chapter 5 will conclude the thesis illustrating the main findings.

Chapter 6 consists of the references mentioned in the thesis.

Literature Review

Historical Overview

Historically, there are mixed evidence on the connectedness of ESG and stock returns. However, the majority agree to a positive relationship between ESG scores and returns with ESG investments outperforming the market or performing better in relation to conventional investments (Kempf and Osthoff, 2007), (Nofsinger and Varma, 2014), (Lins et al., 2017), (Albuquerque et al., 2020). Oppose to that, other studies provide evidence in favour of a negative correlation of ESG and returns (Hong and Kacperczyk, 2009), (Oberndorfer et al., 2013) or no correlation (Buchanan et al., 2018), (Bae et al., 2020), (Aybars and Zehir, 2020).

War related studies and results:

Geopolitical crises have been a centre of attention of financial researches for a long period of time. The assumption that during such crises the stock market will be negatively influenced seems obvious as during wars, investors uncertainty increases due to a heightened probability of things going wrong. Geopolitical tensions influence commodities prices and supply chains, while investors had to revise their risk propensity (Lee et al., 2023). The literature though, extends the research in an attempt to understand the exact implications behind.

Assaf et al. (2023) aim to analyse the effects of Russia-Ukraine war on different country groups such as developed, emerging, Asia-Pacific and NATO member countries. Most severe negative reactions in their stock prices are experienced from the developed countries, especially those in Europe, Middle East and Africa (EMEA). Also, the article highlights a positive relationship between GDP and stability. The heterogeneous impact of the war on equity markets around the globe has also been underlined by (Boubaker et al, 2022).

An interesting study by Verdickt (2020) attempts to deep in manager's and investor's reaction to an "act" or a "threat" in the pre-WWI period from January 1885 to June 1914. Threat was defined as potential military conflicts and act as the onset of a war. It has been revealed that people reaction following a threat cause a temporary decline in stock prices. Immediate after the act, a negative drift has been observed. The evidence comes from Brussels Stock Exchange.

A similar approach was adopted by Najaf et al. (2022) in the context of the recent war in Ukraine to evaluate the consequences of sanctions, conflicts and crises in Russia and Ukraine. The categories were formed by distinguish the key words "sanctions", "conflicts", "crisis" in daily news. Although, both countries experience a decline in their stock market prices caused by war-related news, US sanctions on Russia add to the higher sell-off in Russian indices in the actual beginning of the war and the build-up.

Except from stock indices, other financial assets had gain attention in the outbreak of war such as WTI oil price, and LBMA gold price (Zhang et al., 2023). The results indicate positive shocks in price levels of S&P500 index, oil and gold in the immediate aftermath of the invasion.

Theoretical Background

Efficient market hypothesis (EMH):

The main hypothesis of the thesis — that aerospace and defense companies perform well in the anticipation of wars — is based on the Efficient Market Hypothesis. The notion is that investors adjust their preferences and shift to low ESG investments as geopolitical tensions rises and that is reflected in stock prices.

There are three widespread forms of the Efficient market hypothesis (Fama, 1970).

Strong EMH: All information is accounted for stock prices formation. That is both publicly available information and information not accessible by the public. Consequently, that prohibits the possibility of beating the market through the possession of private information.

Semi-Strong EMH: That form of the hypothesis is more relaxed supposing that only publicly available news is reflected in stock prices. That might give an advantage to people in certain positions that know confidential inside information making it possible for them to outperform the market.

Weak EMF: That is the most lenient. It only assumes historical data knowledge to predict stock prices.

Although, Strong and Semi-Strong forms are controversial, there is a common perspective supporting the Weak EMH (Lee and Yen, 2008). The thesis aligns more with the Semi-strong hypothesis of the efficient market as both high and low ESG returns have excesses compared to the market returns precluding adherence to the Strong form. Moreover, the thesis does not completely rely on past data to explain abnormal returns. It assumes that different months during the conflict has a unique impact on excess returns. It is implied that in each month different events are taking place in different magnitudes and the available information influence investors reactions.

Regression models:

The regression analysis is the ordinary financial research tool used to test relationships among several variables (Waddock, 2022). The basic of the econometric modeling is multiple regression analysis. This method helps to understand the effect of ESG ratings on stock returns amid other factors.

Simple linear regression model: The model is used to quantify the strength of the relationship between two variables. It assumes that one variable x is the explanatory, independent variable and the other variable y is the dependent variable, the outcome. The main assumption of the model is the linear relationship between y and x ($y = a + bx$).

Equation:

$$y = a + bx + e \quad (1)$$

y = dependent variable

x = independent variable

a = y-intercept

b = slope. It represents how much y changes when x increases by 1 unit.

e = error term. The part of y that cannot be explained by x

Other Assumptions: Observations are independent of each other. The variance of the error term is constant across all the values of the independent variable (homoscedasticity) and residuals follow the normal distribution

Multiple linear regression model: The multiple linear regression model is an extend to the Simple linear regression model including more than one independent variable to explain the outcome (y).

Equation:

$$y = a + bx_1 + cx_2 + dx_3 + \ldots + e \quad (2)$$

The coefficients of the independent variables represent the expected change in y for 1-unit increase in the explanatory variable, holding all the other independent variables constant.

The assumptions are followed by the simple linear regression model with the addition of "No multicollinearity" assumption. Independent variables must not be highly correlated with each other.

Dummy variables in regression models:

Dummy variables can be used as independent variables in a regression model. A dummy variable typically created to convert categorical variables to numerical as regression models can only include variables in numerical form. In addition, dummy variables can be helpful to handle non-constant relationships across time. An unconventional way to use dummy variables is to segment the data into time periods when it is suspected that the response variable change behaviour at distinct time-periods (Taljaard et al., 2014). Models including time period dummies adjust for structural breaks in the data due to external factors affecting the observed variable. The interpretation of the coefficient of a dummy variable can be defined as the effect of the dummy variable on the dependent variable, over and above the impact associated with the reference period. The reference period is the category omitted from the model.

The thesis will follow the methodology of Taljaard et al. (2014), creating time period dummies to indicate whether the observed data are included in specific monthly periods around the invasion date.

Fixed effect panel threshold model:

The Fixed-effect-panel-threshold-model introduced by Hansen (1999) in order to provide clearer inferences coming from the threshold models. The model is particularly useful when it is assumed that a change in the relationship between variables might occur after crossing a threshold.

Fixed-effect-panel-threshold-model for single threshold

Equation:

$$y_{it} = \beta_0 + d_{it}\,\beta_1 + x_{it}\,(q_{it} < \gamma)\,\beta_2 + x_{it}\,(q_{it} \geq \gamma)\,\beta_3 + u_i + e_{it} \quad (3)$$

y_{it}: dependent variable of unit i at time t

x_{it}: regime-dependent variable. A variable that its effect on the response variable depends on whether the threshold variable passed a specific threshold.

d_{it}: regime-independent variable. Variables that their impact on the dependent is assumed to be constant regardless of the level of the threshold variable

q_{it}: threshold variable

γ: threshold parameter separating the data into different regimes

u_i: individual fixed effects

e_{it}: error term

The "xthreg" command was applied in Stata as explained by Wang (2015). The model works as follows: First it estimates the threshold value (γ) by searching over its possible values in order to achieve the minimum residual sum of squares within each regime. The lesser the value of RSS, the lesser the variation of the outcome that is not explained by the model. Then the data split up based on this value and different linear regressions are fit to each regime.

Panel data:

Panel data are cross-sectional time series data. A panel dataset consists of a number of observations about unit i=1…, N across time t=1…, T. Units might be people, households, companies etc. Time typically is time periods measured in days, months, years etc. but the t dimension of the panel data can also represent units within clusters. For example, workers within firms.

Basically, a panel data analysis will be conducted considering the longitudinal nature of the data. This approach works well in financial studies, which considers individual heterogeneity and temporal dynamics (Wen et al., 2022). This will allow for a more detailed analysis of how stock returns of firms with different ESG-rating have been affected throughout the conflict.

CAPM- Security market line-Jensen's alpha:

The regression model incorporated in the study is partly based on Capital Asset Pricing Model (Fama and French, 2004).

The formula of CAPM is $E(R_i) = R_f + \beta_i(E(R_m) - R_f)$

$E(R_i)$ represent the expected returns of an investment

R_f is the risk-free rate which is usually represented by government bonds that are considered risk-free

β_i is the Beta of the investment which show the response of the returns of an asset relative to market swings. If it is less than 1 that means that the asset is less volatile than the market

$E(R_m)$ is the expected return of the market

The Security market line present the relationship of Beta which is the risk of the asset relative to the market, with stock returns (Bodie et al., 2013).

Figure 1: Security market line

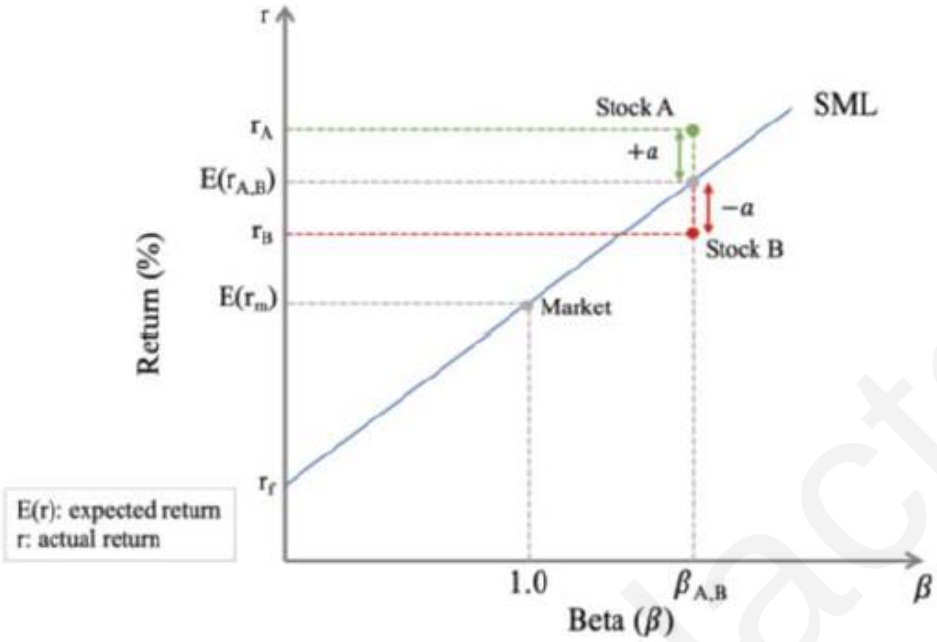

Figure 1 illustrates the security market line. (Bodie et al., 2013)

Jensen’s alpha:

In Figure 1, alpha represents Jensen’s alpha. It shows the amount by which a stock is overpriced or underpriced relative to its expected return predicted by the CAPM. If alpha is positive, it indicates that the asset offers abnormal returns above the expected performance based on its risk level. Conversely, a negative alpha indicates that the asset underperforms relative to expectations.

CAPM and SML provide a theoretical background for interpreting how market movements influence returns. The S&P500 index will be included in the regression model of the thesis as a proxy for the overall market reaction capturing the systemic risk associated with the market. That will attribute to the other independent variables incorporated in the model, the explanation of any excess returns.

Evidence Base

The thesis of this essay is that the Russia-Ukraine conflict has had profound implications on stock performance, with notable distinction between stocks tagged as having low and high Environmental, Social, and Governance (ESG) scores. It proposes that, instead of the traditional view whereby high ESG stocks perform better than low ESG stocks, the introduction of conflict has altered investor preferences towards lower rated defense companies. The shift is caused by the oncoming economic and strategic imperatives of the geopolitical crisis that change investment direction to security and defense sectors having low ESG scores because of their operation nature (Causevic et al., 2022).

The thesis is based on the premise that geopolitical crises like the Russia-Ukraine war create instability and lack of predictability in global markets, consequently affecting investor attitudes and market behaviour. This supports the contention of Xiao et al. (2023), the pursuance of temporary security and profitability at times of high geopolitical risk such as to break up with standard connection between strong ESG scores and stock returns. The article estimates investor flow and the impact on returns in US equity funds during the war in Ukraine according to sustainable investing strategies.

The inferences in the limited literature about the relationship of ESG with EU stock market are diverse. A study conducted by Kick and Rottmann (2022), indicate that the ecological (E) part of the ESG have slightly positive abnormal returns at some of the event windows created around the invasion date. Social (S) and Governance (G) scores appear to be insignificant resulting in the general conjecture that relying on ESG scores is not suitable for risk mitigation in the face of such crises. The study, however, excludes the defense companies. Different outcomes had been presented in the literature comparing the pre-war and post-war period, indicate that retail investors prefer investing in above-average ESG mutual funds (Alvarez and

Lunde, 2023). Additionally, Huq et al. (2022) found that both high and low ESG portfolios outperform the market in terms of risk-adjusted returns. Their tests reveal that low ESG portfolios achieve the lowest risk during war (Huq et al., 2022). The variety of results related to EU has driven me to further investigate that particular crisis — Russia-Ukraine war — in relation to ESG scores in the US environment, where existing literature is scarce.

The thesis accepts that ESG investing is difficult in conditions of geopolitical conflicts. While, the application of ESG criteria is complicated when defense and security become more important in investment scenarios (Waddock, 2022), this paradox in ESG investing, also complicates the idea that higher ESG ratings always lead to superior investment performance (Mattera and Soto, 2023).

A vital point of that research is the fact that low ESG stock returns started to go up a few months before the initiation of the conflict and as we move closer to the invasion date and afterwards, that effect is diminishing. The evidence for that statement is coming from WWII event studies showing that the start of a war provokes a perception that the end of the conflict is close by (Choudhry, 2009), (Schneider and Troeger, 2006). Consequently, the effects of a geopolitical crises as Russia-Ukraine war are more obvious before the official incursion date.

Another significant work contributing to the formation of the main idea and the methodology of the thesis was the study of Le et al. (2022). The authors investigate portfolio returns from October 2021 to June 2022 separating portfolios either consisting of aerospace & defense firms, airline or other industrial firms. They examine the abnormal returns of EU & US firms in the immediate aftermath of the war between Russian and Ukraine, distinguishing the impact week by week. Their findings suggest a positive impact on defense industry and negative on the airlines industry. The effects were more propounded in the first week after the conflict deescalating in the consequent weeks.

Through the exploration of this hypothesis, the essay seeks to provide a contribution in larger tsunami of resilience and adaptability addressed by ESG investment strategy that swoops through geopolitical storm. It aims at shedding more lights on the ways of redefining investment focus in such crises and the future of ethical and sustainable investing (Leins, 2020).

Empirical Analyses

Data Description

The main source of data will comprise a stock performance metric. This covers daily closing stock prices on listed companies in US which is a major international market. The sample originally consists of the companies in S&P 500. All the data has been obtained from Refinitiv database which is commonly known for providing affluent financial information.

The dependent variable is monthly stock returns, which serves as a reflection of how well a company's stock performs. Stock returns will be measured in terms of the percentage changes on stock prices over the study period. This is a regular calculation as used in other financial performance studies (Chen et al., 2015), (Le et al., 2022).

Monthly returns equation:

$$R_{i,t,t+30} = \log(\text{Close-price}_{i,t,t+30}) - \log(\text{Close-price}_{i,t}) \quad (4)$$

where $R_{i,t,t+30}$ is the log return of stock or index i from day t to day t+30

Weekly returns equation:

$$R_{i,t,t+7} = \log(\text{Close-price}_{i,t,t+7}) - \log(\text{Close-price}_{i,t}) \quad (5)$$

where $R_{i,t,t+7}$ is the log return of stock or index i from day t to day t+7

Because the effect of the news about the invasion or other war-related news might not be immediate, I use log returns of the next 30 days and for robustness check for the next 7 days.

The firms included in the study obtained their ESG score from Refinitiv Eikon which provides historical ESG data. Refinitiv Eikon provides ESG ratings for more than 85% of the global market cap. Their methodology is based on more than 630 ESG metrics, making it one of the largest collectors of ESG content operations in the world (Ding et al., 2020). Refinitiv offers comprehensive ESG evaluations that the financial industry uses to rate firms' performance on environmental, social and governance criteria. Companies not having an ESG score for at least one of the years included in the study have been excluded, resulting in a remaining sample of 385 companies. I used ESG data from year t-1 to avoid a lookahead bias.

The post-conflict and pre-conflict stock performance for the period from the start of 2021, more than 1 year before the Russian invasion of Ukraine, until the end of June 2023 will be scrutinized in this study. The period studied ends 3 months before the Israel-Hamas war. In this way, the thesis can focus solely on the effects of the Russia-Ukraine war.

Data on market capitalization of the companies for each year from 2020 until 2022 were collected to calculate the logarithm of their market capitalization, acting as a proxy for company size. Stock market capitalization, which is the worth of a company's outstanding shares is crucial when it comes to stock analysis (Bonga and Sithole, 2019). Size is an important variable to control as stated by Cakici and Zaremba (2021), since bigger companies tend to obtain higher ESG scores.

Another control variable proven to be essential following Fama and French (2015) is the investment being defined as:

$$INV = \Delta \text{Total assets}_{t-2} / \text{Total assets}_{t-3} \quad (6)$$

Investment perceived as an indication of the future growth of a company which influence market expectations. Including investment as a control variable will allow for isolating the effect of the war and its consequential impact on market sentiment, on returns.

Further, book to market ratio was added calculated as the common shareholder's equity divided by the market capitalization, both values used as reported in year t-2 (Novy-Marx, 2013).

Data on market capitalization, total assets and common shareholder's equity were collected from Datastream and Worldscope database within Refinitiv. It is common to use accounting data from the previous year when studying an event that occurred after June. Since the Russian invasion of Ukraine took place in February, we use accounting data from year t-2.

Descriptive Analyses

Descriptive statistics will be used in the first stage of analysis to make sense of the data set. These will entail the mean, median, standard deviation, minimum and maximum value of stock returns as well as ESG ratings. Descriptive statistics are essential in providing an initial context of the data and help identify some potential patterns or anomalies (Caldara and Iacoviello, 2022).

Table 1: Descriptive statistics

	Mean	**Median**	**St. dev**	**Min**	**Max**
RETURNS	-0.002292	-0.000925	0.049807	-0.424641	0.297075
MARKET	-0.002218	0.000259	0.026862	-0.072023	0.051697
ESG	65.226756	67.170000	13.768289	21.830000	93.280000

MCAP	7.588508	7.529363	0.445781	6.548729	9.402913
INV	0.144329	0.074396	0.388234	-0.628783	5.885012
BM	1.147027	0.278875	4.535488	-0.842377	71.151070
HIGH ESG	-0.003442	-0.001877	0.046654	-0.268342	0.201457
LOW ESG	-0.001531	-0.000244	0.051774	-0.424641	0.297075

The Table 1 shows descriptive statistics for RETURNS, which measure monthly returns. HIGH ESG includes the descriptive statistics of the monthly returns for the companies with ESG ≥ 71.1 and LOW ESG for companies with ESG less than 71.1. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2.

A correlation analysis will be conducted to investigate the initial associations between stock returns and market returns. The strength and direction of these relationships will be guided by Pearson's correlation coefficient. The correlation of ESG and stock returns is included, but the correlation coefficients shown in Tables 2a, 2b and 2c appear to be small. This observation can be attributed to the assumption of the thesis that these variables have a non-linear relationship. Therefore, this analysis cannot shed light on whether higher ESG ratings can be paired to improved stock performance during the conflict period as alluded by (Garcia et al., 2017).

Table 2a: Correlation matrix

	RETURNS	MARKET	ESG	MONTH	MCAP	INV	BM
RETURNS	1.00						

MARKET	0.47	1.00					
ESG	-0.02	-0.01	1.00				
MONTH	-0.09	-0.07	0.07	1.00			
MCAP	-0.03	-0.03	0.29	0.04	1.00		
INV	-0.02	0.00	-0.11	-0.03	0.05	1.00	
BM	-0.01	0.00	-0.01	-0.02	-0.12	0.03	1.00

The Table 2a shows the correlations for the dependent and independent variables. RETURNS measure monthly returns. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MONTH is a sequential numeric variable where each number corresponds to a consecutive month, starting with the value of 1 for the first month in the dataset. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2.

Table 2b: Correlation matrix of the High ESG regime

	HIGH ESG	**MARKET**	**ESG**	**MCAP**	**INV**	**BM**
HIGH ESG	1.00					
MARKET	0.49	1.00				
ESG	0.00	-0.01	1.00			
MCAP	-0.01	-0.03	0.23	1.00		
INV	-0.05	0.01	-0.03	0.10	1.00	
BM	0.01	0.00	-0.01	-0.15	0.06	1.00

The Table 2b shows the correlations for the dependent and independent variables. HIGH ESG measures monthly returns for the high ESG regime. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MONTH is a sequential numeric variable where each number corresponds to a consecutive month, starting with the value of 1 for the first month in the dataset. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2.

Table 2c: Correlation matrix of the High ESG regime

	LOW ESG	MARKET	ESG	MCAP	INV	BM
LOW ESG	1.00					
MARKET	0.46	1.00				
ESG	-0.01	-0.02	1.00			
MCAP	-0.04	-0.03	0.09	1.00		
INV	-0.02	0.00	-0.08	0.09	1.00	
BM	-0.02	0.01	-0.08	-0.12	0.03	1.00

The Table 2c shows the correlations for the dependent and independent variables. LOW ESG measures monthly returns of the low ESG regime. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MONTH is a sequential numeric variable where each number corresponds to a consecutive month, starting with the value of 1 for the first month in the dataset. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2.

Regression Analyses

This research includes a hypotheses testing stage aimed at proving the allegations asserted in relation to the effect of the Russo-Ukrainian War on high and low ESG stock returns. At this point, these hypotheses will have been subjected to rigorous statistical testing.

Formulation of Hypothesis:

Hypothesis 1 (H1): The relationship between ESG and abnormal returns across time is not linear.

Hypothesis 2 (H2): During the months around the Russia-Ukraine war, stock returns for companies with low ESG ratings had outperformed the market. Specifically, from 24/12/2021 to 23/03/2022.

Hypothesis 3 (H3): From 24/11/2021 to 23/12/2021, the excess returns for high ESG firms are higher than the excess returns for low ESG firms.

Hypothesis 4a (H4a): The month from 24/12/2021 to 23/01/2022, the excess returns for low ESG companies are higher than the excess returns for high ESG companies.

Hypothesis 4b (H4b): The month from 24/01/2022 to 23/02/2022, the excess returns for the low ESG group of companies are higher than the excess returns for the high ESG group of companies.

Hypothesis 5 (H5): The first month after the war, the abnormal returns for the low ESG regime are not higher than those for the high ESG regime.

These hypotheses are based on the presupposition listed in preliminary explanation according to which geopolitical crises make investors turn to those industries that seem more durable or vital – such as military – and, thus, have lower "ESG"-scores. There are 10 firms from the Aerospace and defence sector in the sample under investigation, with an average ESG rating of 59,18 across the years 2021-2023.

Figure 2: Histogram of the ESG scores

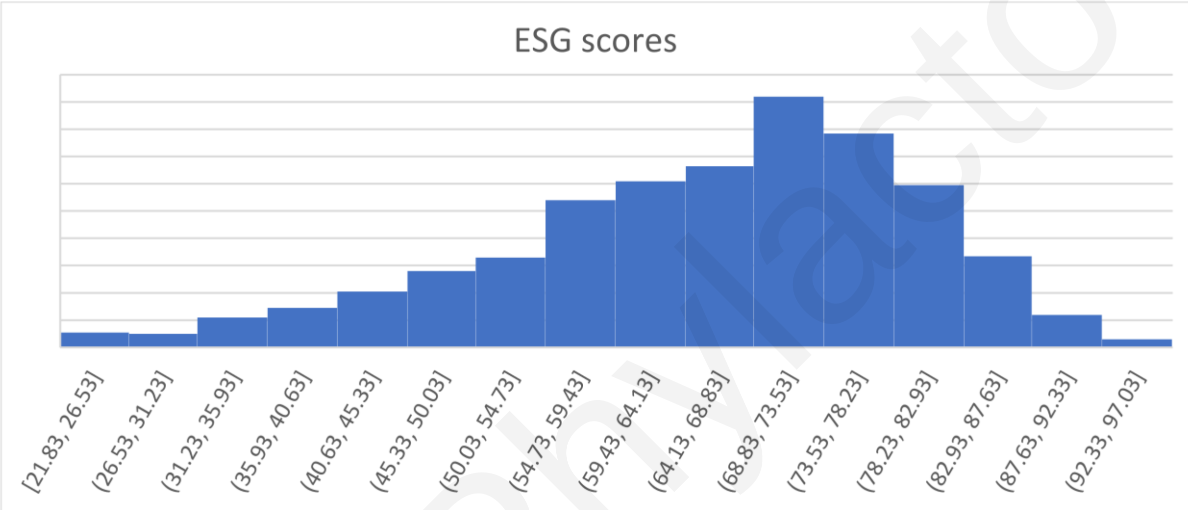

Figure 2 is a histogram of the average ESG scores from 2021 to 2023 for all the firms in the sample.

For hypotheses 3 and 4 to be formed, the Chow-test had been conducted and showed a structural break of High-Low ESG returns at 20/12/2021. It is assumed that before the structural break, the excess returns for the High ESG group are higher than those for the Low ESG group. For observations after the 20th of December 2021, the opposite is assumed.

Hypotheses 4 and 5 are supported by Schneider and Troeger (2006), who showed that the start of a war can be perceived by investors as a sign that the conflict will soon end. Therefore, it is assumed that the impact of the war will get narrower or even disappear within the first month after the invasion.

Figure 3: Time-series plot of the HIGH ESG returns minus the LOW ESG returns.

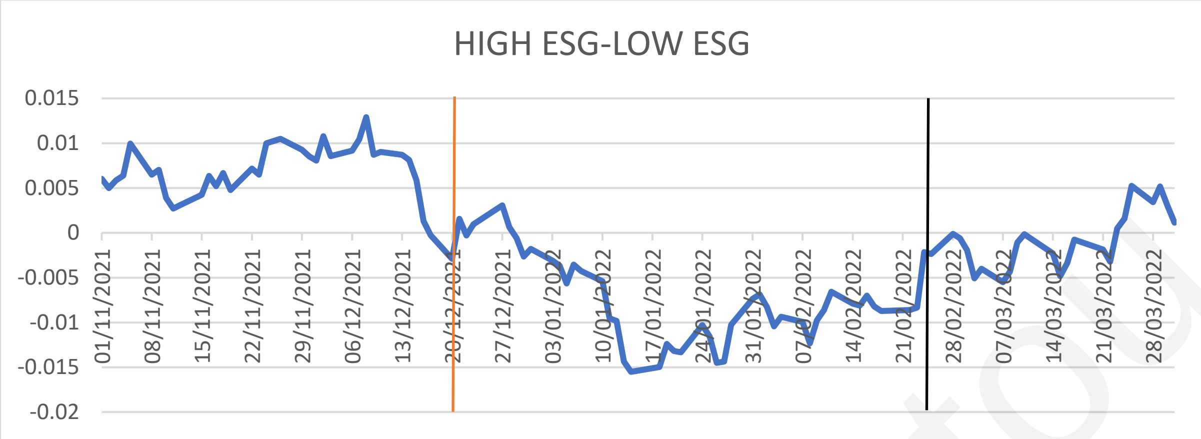

Figure 3 is a time-series plot from 01/11/2021 to 31/03/2022, presenting the returns for the HIGH ESG regime minus the returns for the LOW ESG regime. The orange vertical line on December 20, 2021, indicates the structural breakpoint. The black vertical line on February 24, 2022, marks the official date of the invasion.

Figure 4: Time-series plot of the excess returns for High ESG and Low ESG

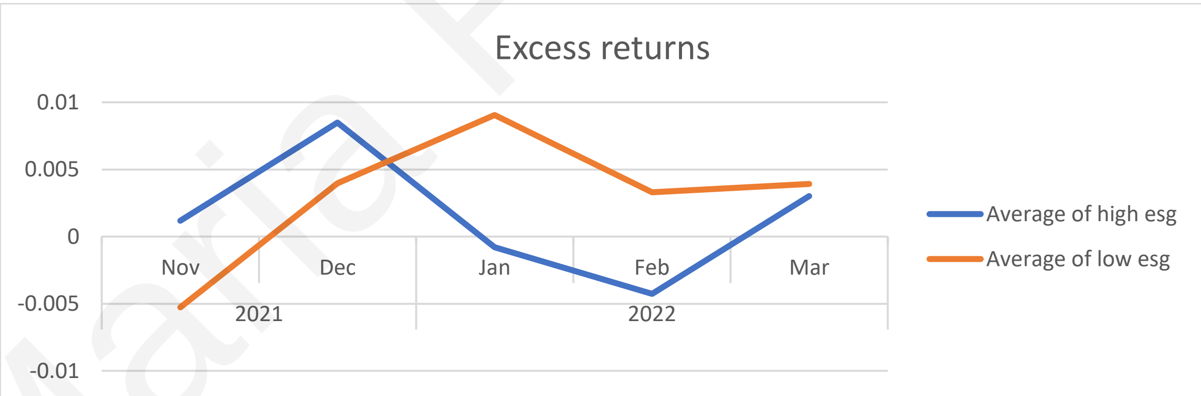

Figure 4 is a time-series plot from 01/11/2021 to 31/03/2022, showing monthly trends of the average excess returns for the high ESG companies and the Low ESG companies.

Testing Methodology:

The analysis consists of two main procedures.

The first one is the implementation of the fixed-effect-panel-threshold-model.

Equations:

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2 R_{Mt,\ t+30} *MONTH\ (ESG_{it-1} \geq \gamma_1) + e_{it} \quad (7)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} *MCAP *INV *BM *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2 R_{Mt,\ t+30} *MCAP *INV *BM *MONTH\ (ESG_{it-1} \geq \gamma_1) + e_{it} \quad (8)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} *MCAP *INV *BM *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2 R_{Mt,\ t+30} *MCAP *INV *BM *MONTH\ (ESG_{it-1} \geq \gamma_1) + \mathrm{FE} + e_{it} \quad (9)$$

Variables:

$R_{it,\ t+30}$: The dependent variable. Log return for company i for day t to day t+30

$R_{Mt,\ t+30}$: Log return of the S&P500 index for day t to day t+30, used as a market return reference

ESG_{it-1} = The threshold variable. ESG score of company i in year t-1

MONTH = A sequential numeric variable where each number corresponds to a consecutive month, starting with the value of 1 for the first month in the dataset.

MCAP = Log of market capitalization in year t-1

INV = The investment rate calculated as ΔTotal assets$_{t-2}$/Total assets$_{t-3}$

BM = Book value in year t-2 divided by market capitalization in year t-2

FE : The individual fixed effects. This term captures all unobserved heterogeneity that could consistently affect the dependent variable over time but varies between firms.

e_{it} : The error term. It accounts for the random variation in monthly returns that cannot be explained by the model.

In equation (7), *MONTH* is identified as the regime-dependent variable. In equations (8) and (9), $R_{Mt,\ t+30}$, *MCAP*, *INV*, *BM* and *MONTH* are all considered regime-dependent variables. The impact of these variables on monthly returns is assumed to be influenced by the value of the threshold variable.

The fixed-effect-panel-threshold model performed in Stata using the "**xthreg**" command as described by (Wang, 2015). Stata handle the fixed effects internally which makes the command particularly powerful and user-friendly for panel data analysis. The setup of the model allows it to examine how changes in $R_{Mt,\ t+30}$, *MCAP*, *INV*, *BM* and *MONTH*, influence the effect of the ESG scores that fall below and above a specific threshold.

A second procedure was followed to study in more depth the relationship between High ESG and Low ESG regimes and returns around the invasion date. The data were separated into High and Low ESG groups according to the threshold estimation from the fixed-effect-panel-threshold model. These groups were revised annually throughout the study period.

Then, multiple regression analysis will be used, to explore the data further. This method would enable to comprehend the influence of certain months on High vs low ESG stock returns, adjusting for various factors such as market capitalization (Smales, 2021).

Two separate regressions will be conducted and compared.

Equations:

High ESG

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + e_{it} \quad (10)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + e_{it} \quad (11)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + FE + e_{it} \quad (12)$$

Low ESG

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + e_{it} \quad (13)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + e_{it} \quad (14)$$

$R_{it, t+30} = \beta_0 + \beta_1 R_{Mt, t+30} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 +$

$\beta_6 MCAP + \beta_7 INV + \beta_8 BM + \text{FE} + e_{it}$ (15)

Variables:

$R_{it, t+30}$: The dependent variable. Log return for company i for day t to day t+30

$R_{Mt, t+30}$: Log return of the S&P500 index for day t to day t+30, used as a market return reference

MCAP = Log of market capitalization in year t-1

INV = The investment rate calculated as ΔTotal assets_{t-2}/Total assets_{t-3}

BM = Book value in year t-2 divided by market capitalization in year t-2

MONTH-3: Dummy variable taking the value of 1 when observation is between 24/11/2021-23/12/2021 and otherwise is 0.

MONTH-2: Dummy variable taking the value of 1 when observation is between 24/12/2021-23/01/2022 and otherwise is 0.

MONTH-1: Dummy variable taking the value of 1 when observation is between 24/01/2022-23/02/2022 and otherwise is 0. The last month before the war.

MONTH1: Dummy variable taking the value of 1 when observation is between 24/02/2022-23/03/2022 and otherwise is 0. The first month after the war.

FE: Firm fixed effects

e_{it} : The error term. It accounts for the random variation in monthly returns that cannot be explained by the model.

Table 3: High and Low ESG regression results

	High ESG			Low ESG		
	(10)	**(11)**	**(12)**	**(13)**	**(14)**	**(15)**
MARKET	0.9513*** (0.000) [0.006]	0.9529*** (0.000) [0.006]	0.9310*** (0.0000) [0.006]	0.9583*** (0.000) [0.005]	0.9577*** (0.000) [0.005]	0.9340*** (0.0000) [0.0048]
MONTH-3	0.0122*** (0.000) [0.001]	0.0123*** (0.000) [0.001]	0.0098*** (0.0000) [0.0008]	0.0025*** (0.000) [0.001]	0.0032*** (0.000) [0.001]	0.0008* (0.0738) [0.0007]
MONTH-2	0.0034*** (0.000) [0.001]	0.0034*** (0.000) [0.001]	0.0036*** (0.0000) [0.0009]	0.0060*** (0.000) [0.001]	0.0061*** (0.000) [0.001]	0.0065*** (0.0000) [0.0008]
MONTH-1	0.0026*** (0.000) [0.001]	0.0025*** (0.000) [0.001]	0.0044*** (0.0000) [0.0007]	0.0052*** (0.000) [0.001]	0.0049*** (0.000) [0.001]	0.0070*** (0.0000) [0.0006]
MONTH1	0.0021*** (0.005) [0.001]	0.0019*** (0.010) [0.001]	0.0039*** (0.0000) [0.0007]	0.0035*** (0.000) [0.001]	0.0027*** (0.000) [0.001]	0.0049*** (0.0000) [0.0007]
MCAP		0.0010*** (0.000)	-0.0434*** (0.0000)		-0.0030*** (0.000)	-0.0415*** (0.0000)
INV		-0.0117*** (0.000)	-0.0033*** (0.0035)		-0.0023*** (0.000)	0.0002 (0.6755)
BM		0.0429*** (0.001)	-0.0001 (0.2871)		-0.0004*** (0.000)	-0.0002 (0.2980)

TH-1	71.1* (0.0968)	71.1* (0.0667)	71.1* (0.0533)	71.1* (0.0968)	71.1* (0.0667)	71.1* (0.0533)
FE	No	No	Yes	No	No	Yes
CONTROL	No	Yes	Yes	No	Yes	Yes
R^2	0.244	0.247	0.2579	0.211	0.210	0.2228
N	93626	93626	93626	164324	164324	164324

Table 3 present the regression results for high and low ESG using the equations from (10) to (15). RETURNS measure monthly returns. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2. MONTH-3 represent the month from 24/11/2021 to 23/12/2021. MONTH-2 represent the month from 24/12/2021 to 23/01/2022. MONTH-1 represent the month from 24/01/2022 to 23/02/2022. MONTH1 represent the month from 24/02/2022 to 23/03/2022. In parenthesis the p-values are presented and, in the brackets, the standard errors are reported. TH-1 row shows the estimation of the threshold (γ_1) of equations (7), (8), and (9). In the parenthesis the p-value of the single threshold effect test is reported, employing a bootstrap method with 300 replications. * , ** , *** indicate the significance levels of 10%, 5% and 1%.

Table 4: High and Low ESG regression results

	High ESG (11)	Low ESG (14)
MARKET	0.9527 [0.0056]	0.9559 [0.0048]
MONTH-3	0.0122 [0.0008]	0.0031 [0.0007]
MONTH-2	0.0033 [0.0009]	0.0060 [0.0007]

MONTH-1	0.0024 [0.0008]	0.0044 [0.0007]
MONTH1	0.0018 [0.007]	0.0026 [0.0006]
MCAP	0.0009	-0.0031
INV	-0.0117	-0.0023
BM	0.000	-0.0004
FE	No	No
N	93626	164324

Table 4 present the regression results using the bootstrap method with 300 replications, for high and low ESG using the equations (11) and (14). RETURNS measure monthly returns. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2. MONTH-3 represent the month from 24/11/2021 to 23/12/2021. MONTH-2 represent the month from 24/12/2021 to 23/01/2022. MONTH-1 represent the month from 24/01/2022 to 23/02/2022. MONTH1 represent the month from 24/02/2022 to 23/03/2022. In brackets the standard errors are reported.

Validity of results

The bootstrap method used by "xthreg" command performing the fixed-effect-panel-threshold model, is particularly useful in complex models like threshold models where standard assumptions such as normality or homoscedasticity might be violated. Hansen (1997), noted that the p-values derived from the bootstrap are asymptotically valid as the method attains the first-order asymptotic distribution. The fixed-effect-panel-threshold model is chosen for its ability to let the data decide the threshold value rather than being imposed arbitrarily. This feature offers an objective identification of the threshold value, estimated specifically for the provided dataset. In this way, the threshold is not based on theoretical assumptions and better suits the real-world data of the study. Therefore, the model adapts to the inherent characteristics of the data offering precise and relevant estimations for the specific place and period of the investigation-namely, the US stock market during the Russia-Ukraine war. The method is particularly meaningful in financial economics where market conditions can dramatically alter the behaviour of key variables. Although the threshold effect appears to be statistically significant, the thesis will apply additional regressions to further examine the two regimes defined by the threshold.

The assumptions of the multiple regression analysis must be tested in order to enhance the validity of the results. The multiple regression models comparing High and low ESG regimes have been assessed for heteroskedasticity and autocorrelation. Within each regime, multicollinearity among the predictors was assessed.

The Durbin-Watson test had been used to test for autocorrelation. The null hypothesis is that the model has no autocorrelation. The Durbin-Watson statistic in all cases falls within the accepted range of [1.50, 250]. Hence, it is reasonable to assume that the residuals are uncorrelated with each other. The results are close to but below 2 indicating that there is slightly positive autocorrelation among residuals.

Breusch-Pagan test had been performed to evaluate the homoscedasticity assumption. The test considers the null hypothesis that there is homoskedasticity. In case the p-value is lower than 5%, the null hypothesis is significantly being rejected and therefore the model residuals are heteroscedastic. The results suggest the rejection of homoscedasticity, which leads to unreliable hypothesis testing. Robust standard errors have been used to ensure the unbiasedness of conclusions about the significance of the estimates.

Clustered standard errors were used for the regressions including firm fixed effects. Among Clustered, OLS, Fama-MacBeth and Newey West standard errors, Clustered standard errors are the only unbiased when accounting for firm fixed effects. A comparison between those methods had been conducted by Petersen (2008) stating also that clustered standard errors are heteroscedasticity robust.

A critical assumption in regression analysis is the normality of residuals. Therefore, the Kolmogorov-Smirnov test was implemented, resulting in a p-values of 0.061 and 0.055 providing insufficient evidence to reject the normality assumption for either the High or Low ESG regime. For further robustness of the results, the bootstrap method was also implemented for the regression analysis of companies with High and Low ESG ratings. This method is widely applicable and especially when there are concerns about the distribution of the data.

Scatter plots have been constructed to visualize the relationship between the market returns and the stock residuals in each regime. The scatter plots display a relatively clear trend line, suggesting a linear relationship.

Figure 5a: Scatter plot in High ESG regime

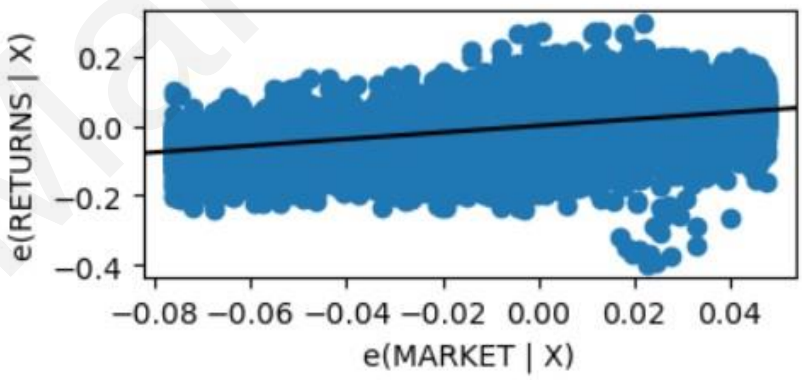

Figure 5a visualizes the relationship between market returns and the residuals of the dependent variable (returns for High ESG firms)

Figure 5b: Scatter plot in Low ESG regime

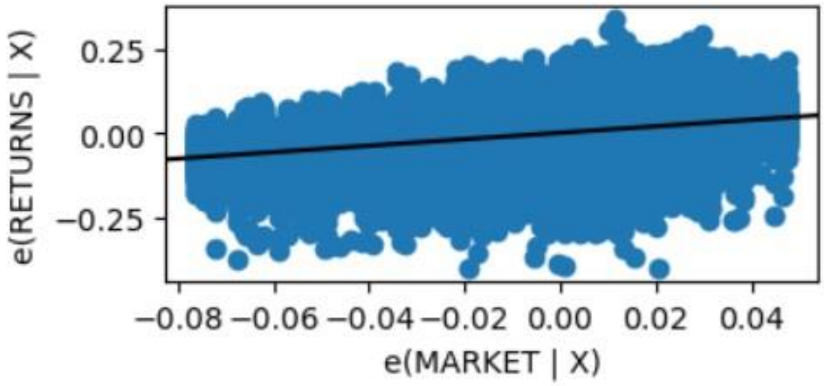

Figure 5b visualizes the relationship between market returns and the residuals of the dependent variable (returns for Low ESG firms)

Discussion of the results

Table 3 suggesting the ESG score of 71.1 as a threshold shown in row TH-1. The null hypothesis posits that there is no threshold, with the relationship of ESG with returns being linear. The alternative hypothesis is the existence of a single threshold. The null hypothesis should be rejected at 90% confidence level supporting Hypothesis 1 of the thesis. However, the effect of the threshold does not appear to be statistically significant at 5% or 1% significant level. The threshold estimation is higher than the average ESG score of Aerospace and defence companies suggesting that the majority of these companies likely fall into the Low ESG group.

The Table 3 presents estimates of abnormal returns for companies included in the High ESG group and Low ESG groups, for the third, second and first months before the start of the Ukraine war, and for the first month after. The High ESG regime includes the companies with ESG scores ≥ 71.1 and the Low ESG regime consists of the rest of the companies with ESG scores lower than 71.1.

As all the coefficients of (*MONTH-3, MONTH-2, MONTH-1, MONTH1*) are positive and statistically significant, the Hypothesis 2 is accepted. Although the hypothesis statement is about the Low ESG regime, it can be observed from the summary statistics in Table 3 that the High ESG regime had also outperformed the market.

Market returns coefficient is a representation of the market sensitivity (beta). All the *MARKET* coefficients are slightly less than 1. This can suggest that the firm's stock is less volatile than the market.

To examine the Hypotheses 3,4 and 5, the coefficient estimates of the monthly dummy variables (*MONTH-3, MONTH-2, MONTH-1, MONTH1*) must be compared.

All these coefficient estimates are statistically significant at the 99% confidence level. During the period from 24/11/2021 to 23/12/2021, which is up to two months before the invasion, the abnormal returns for the High ESG regime are sufficiently higher than those for the Low ESG regime. Specifically, Table 3 shows the estimated regression coefficients for the high ESG group incorporating control variables, where the abnormal returns for that period are 0.0123. In contrast, the excess returns during the same period for the Low ESG group are 0.0032.

To confirm the significance of the difference of these two coefficients, two tailed z-tests will be conducted.

Z-tests for Comparative analysis:

1. Null hypothesis (H_0): $\beta_{2,lowESG} = \beta_{2,highESG}$
2. Null hypothesis (H_0): $\beta_{3,lowESG} = \beta_{3,highESG}$
3. Null hypothesis (H_0): $\beta_{4,lowESG} = \beta_{4,highESG}$
4. Null hypothesis (H_0): $\beta_{5,lowESG} = \beta_{5,highESG}$

Table 5: Z-tests results

	(10) and (13)	(11) and (14)	(12) and (15)
MONTH-3 (β_2)	6.8600***	6.4356***	8.4665***
MONTH-2 (β_3)	1.8388*	1.9095*	2.4083**
MONTH-1 (β_4)	1.8388*	1.6973*	2.8201***
MONTH1 (β_5)	0.9901	0.5658	1.0102
FE	No	No	Yes
CONTROL	No	Yes	Yes

Table 5 present the absolute values of the z-statistics for the tests 1-4 comparing the coefficient estimates for Low and High ESG groups across different monthly periods from equations (10) and (13), (11) and (14), (12) and (15). * , ** , *** indicate the significance levels of 10%, 5% and 1% at which the null hypothesis is rejected.

From 24/11/2021 to 23/12/2021 there is significant difference between the High and Low ESG regimes with the higher abnormal returns being observed for the High ESG regime supporting the Hypothesis 3 of the thesis.

During the month from 24/12/2021 to 23/01/2022, the results were reversed. Greater abnormal returns were observed in the Low ESG group compared to the High ESG group. Moving into the month 24/12/2021 - 23/01/2022, the excess returns for the Low ESG increased, while those for the High group decreased. A similar conclusion applies for the subsequent month (24/01/2022 – 23/02/2022). During the last month before the war, the Low ESG group of companies experienced greater excess returns compared to the companies with High ESG scores and therefore Hypothesis 4 of the study can be accepted.

During the first month after the invasion, the hypothesis cannot be rejected at any significant level and therefore there is not sufficient evidence to support that the two regimes produce different excess returns aligning with Hypothesis 5 of the study. As the invasion date approaches, the difference between the two regimes lessens suggesting a decrease in the significance of the higher returns previously earned by Low ESG companies.

From 24/11/2021 to 23/12/2021, stock returns for High ESG firms are considerably higher than those for Low ESG firms but during the consequent month the trend alters. During the following months, 24/12/2021 - 23/01/2022, 24/01/2022 - 23/02/2022, 24/02/2022 - 23/03/2022, the excess returns for Low ESG surpass those for High ESG with a decreasing rate. Additionally, the disagreement between the two regimes in the immediate subsequent month after the invasion is not statistically significant, demonstrating a reduction in the effect after the official start of the war.

On 17th of December 2021, Russian's president made a proposal to prohibit Ukraine from joining NATO, which got rejected by Ukraine. This is considered the most important war-related event near the start of the Russia-Ukraine war as it marked the escalation of tensions between the two countries and act as a signal for investors to anticipate the upcoming war. The results of the regressions suggests that the consequences of the war on the US stock market appeared during the month from 24/12/2021 to 23/01/2022, which is the consequent month after this key event. Consequences of the war refer to the fact that abnormal returns for Low ESG companies surpassed those for High ESG companies. The immediate reaction of the market can be justified by the sensitivity of financial markets to such geopolitical tensions, leading to adjustments before actual military actions commenced. A possible explanation for the appearance of war effects before the beginning of the war, and not after, is that the invasion could be interpreted by investors as a near resolution to the conflict. The statement was investigated by Choudhry (2009) and Schneider and Troeger (2006) in the context of WWII, Gulf War and the wars in the former Yugoslavia, providing evidence that markets often react sharply to initial signs of a war, with the effects getting smaller as the war progresses. Schneider and Troeger (2006) analysis discuss how people react optimistically towards military actions referred to as "war rallies", as they could speed up the end of hostilities. They also highlight the privileges of the defence sector during intense conflicts, often earning notable profits. Figure 6 shows that from September 2021 until May 2022, the Aerospace and Defence sector experienced higher returns compared to the market returns proxied by the S&P500 index, indicating that the findings noted by previous studies are also valid in the case of the Russia-Ukraine war.

Figure 6: Time-series plot for AEROSPACE AND DEFENCE sector returns

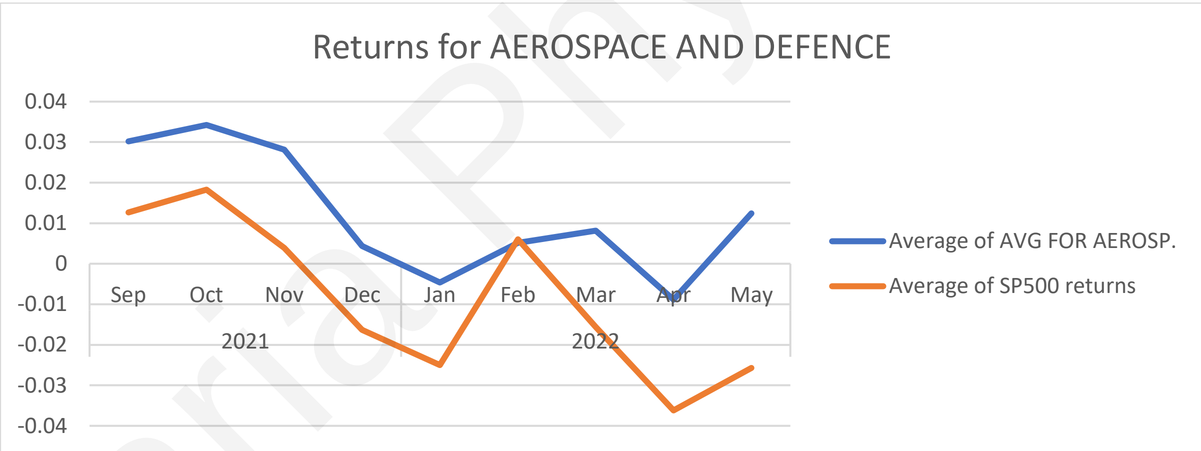

Figure 6 is a time-series plot from 01/09/2021 to 31/05/2022, showing monthly trends of the average returns for the companies in the AEROSPACE AND DEFENCE sector and the average returns of the S&P500 index.

Robustness check

By engaging robustness checks, one can ensure the results are not by-products of specific model specifications or data artifacts. To enhance the reliability of its conclusions, this research will employ a robustness check.

To test the robustness of the results, one can re-estimate primary regression models using different specifications. Fagiolo et al. (2019) suggest such alteration of independent and control variables inclusion-transformation, making this method suitable for the financial data analysis as well.

Various Regressions had been implemented, including control variables and firm-fixed effects to enhance the robustness of the findings. The first robustness check implemented in that section of the thesis will add more monthly dummy variables to ensure the findings of the thesis are applicable over a broader period around the invasion. The second check will involve tests on weekly returns to robust further the results and check if the hypothesis is still valid regarding weekly returns.

First Robustness check:

Equations:

<u>High ESG</u>

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4\ MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + e_{it} \quad (16)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4 MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + \beta_{10} MCAP + \beta_{11} INV + \beta_{12} BM + e_{it} \quad (17)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4 MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + \beta_{10} MCAP + \beta_{11} INV + \beta_{12} BM + FE + e_{it} \quad (18)$$

<u>Low ESG</u>

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4 MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + e_{it} \quad (19)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4 MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + \beta_{10} MCAP + \beta_{11} INV + \beta_{12} BM + e_{it} \quad (20)$$

$$R_{it,\ t+30} = \beta_0 + \beta_1 R_{Mt,\ t+30} + \beta_2 MONTH\text{-}5 + \beta_3 MONTH\text{-}4 + \beta_4 MONTH\text{-}3 + \beta_5 MONTH\text{-}2 + \beta_6 MONTH\text{-}1 + \beta_7 MONTH1 + \beta_8 MONTH2 + \beta_9 MONTH3 + \beta_{10} MCAP + \beta_{11} INV + \beta_{12} BM + FE + e_{it} \quad (21)$$

Variables:

$R_{it,\ t+30}$: The dependent variable. Log return for company i for day t to day t+30

$R_{Mt,\ t+30}$: Log return of the S&P500 index for day t to day t+30, used as a market return reference

MCAP = Log of market capitalization in year t-1

INV = The investment rate calculated as ΔTotal $assets_{t-2}$/Total $assets_{t-3}$

BM = Book value in year t-2 divided by market capitalization in year t-2

MONTH-5: Dummy variable taking the value of 1 when observation is between 24/09/2021-23/10/2021 and otherwise is 0.

MONTH-4: Dummy variable taking the value of 1 when observation is between 24/10/2021-23/11/2021 and otherwise is 0.

MONTH-3: Dummy variable taking the value of 1 when observation is between 24/11/2021-23/12/2021 and otherwise is 0.

MONTH-2: Dummy variable taking the value of 1 when observation is between 24/12/2021-23/01/2022 and otherwise is 0.

MONTH-1: Dummy variable taking the value of 1 when observation is between 24/01/2022-23/02/2022 and otherwise is 0. The last month before the war.

MONTH1: Dummy variable taking the value of 1 when observation is between 24/02/2022-23/03/2022 and otherwise is 0. The first month after the war.

MONTH2: Dummy variable taking the value of 1 when observation is between 24/03/2022-23/04/2022 and otherwise is 0. The first month after the war.

MONTH3: Dummy variable taking the value of 1 when observation is between 24/04/2022-23/05/2022 and otherwise is 0. The first month after the war.

FE: Firm fixed effects

e_{it} : The error term. It accounts for the random variation in monthly returns that cannot be explained by the model.

Table 7: High and Low ESG regression results for the first Robustness check

	High ESG			Low ESG		
	(16)	**(17)**	**(18)**	**(19)**	**(20)**	**(21)**
MARKET	0.9674*** (0.000) [0.006]	0.9683*** (0.000) [0.006]	0.9691*** (0.0000) [0.0065]	0.09742*** (0.000) [0.005]	0.09728*** (0.000) [0.005]	0.9786*** (0.0000) [0.0052]
MONTH-5	-0.0033*** (0.000) [0.001]	-0.0034*** (0.000) [0.001]	-0.0058*** (0.0000) [0.0007]	-0.0105*** (0.000) [0.001]	-0.0107*** (0.000) [0.001]	-0.0119*** (0.0000) [0.0006]
MONTH-4	0.0022*** (0.001) [0.001]	0.0022*** (0.001) [0.001]	-0.0012* (0.0507) [0.0006]	-0.0055*** (0.000) [0.001]	-0.0057*** (0.000) [0.001]	-0.0092*** (0.0000) [0.0005]
MONTH-3	0.0131*** (0.000) [0.001]	0.0132*** (0.000) [0.001]	0.0102*** (0.0000) [0.0008]	0.0055*** (0.000) [0.001]	0.0054*** (0.000) [0.001]	0.0006 (0.3607) [0.0007]
MONTH-2	0.0045*** (0.000) [0.001]	0.0044*** (0.000) [0.001]	0.0051*** (0.0000) [0.0009]	0.0067*** (0.000) [0.001]	0.0068*** (0.000) [0.001]	0.0076*** (0.0000) [0.0008]
MONTH-1	0.0025*** (0.000) [0.001]	0.0023*** (0.000) [0.001]	0.0049*** (0.0000) [0.0007]	0.0046*** (0.000) [0.001]	0.0047*** (0.000) [0.001]	0.0072*** (0.0000) [0.0006]
MONTH1	0.0032*** (0.000) [0.001]	0.0030*** (0.000) [0.001]	0.0043 (0.0000) [0.0007]	0.0031*** (0.000) [0.001]	0.0032*** (0.000) [0.001]	0.0050* (0.0000) [0.0007]

MONTH2	0.0121*** (0.000) [0.001]	0.0120*** (0.000) [0.001]	0.0120*** (0.000) [0.0009]	0.0115*** (0.000) [0.001]	0.0115*** (0.000) [0.001]	0.0112*** (0.0000) [0.0007]
MONTH3	-0.0030*** (0.000) [0.001]	-0.0032*** (0.000) [0.001]	-0.0025*** (0.0007) [0.0007]	-0.0030*** (0.000) [0.001]	-0.0029*** (0.000) [0.001]	-0.0013** (0.0467) [0.0006]
TH-1	71.1* (0.0968)	71.1* (0.0667)	71.1* (0.0533)	71.1* (0.0968)	71.1* (0.0667)	71.1* (0.0533)
FE	No	No	Yes	No	No	Yes
CONTROL	No	Yes	Yes	No	Yes	Yes
R^2	0.246	0.249	0.2605	0.214	0.216	0.2272
N	93626	93626	93626	164324	164324	164324

Table 7 present the regression results for high and low ESG using the equations from (16) to (21). RETURNS measure monthly returns. MARKET represent the monthly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder's equity) in year t-2 divided by market capitalization in year t-2. MONTH-5 represent the month from 24/09/2021 to 23/10/2021. MONTH-4 represent the month from 24/10/2021 to 23/11/2021.MONTH-3 represent the month from 24/11/2021 to 23/12/2021. MONTH-2 represent the month from 24/12/2021 to 23/01/2022. MONTH-1 represent the month from 24/01/2022 to 23/02/2022. MONTH1 represent the month from 24/02/2022 to 23/03/2022. MONTH2 represent the month from 24/03/2022 to 23/04/2022. MONTH3 represent the month from 24/04/2022 to 23/05/2022. In parenthesis p-values are presented and, in the brackets, the standard errors are reported. TH-1 row shows the estimation of the threshold (γ_1) of equations (7), (8), and (9). In the parenthesis the p-value of the single threshold effect test is reported, employing a bootstrap method with 300 replications. * , ** , *** indicate the significance levels of 10%, 5% and 1%.

Second Robustness check:

Fixed-effect-panel threshold model:

Equations:

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2\ R_{Mt,\ t+7} *MONTH\ (ESG_{it-1} \geq \gamma_1) + \text{FE} + e_{it} \quad (22)$$

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} *MCAP *INV *BM *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2 R_{Mt,\ t+7} *MCAP *INV *BM *MONTH\ (ESG_{it-1} \geq \gamma_1) + e_{it} \quad (23)$$

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} *MCAP*INV*BM *MONTH\ (ESG_{it-1} < \gamma_1) + \beta_2 R_{Mt,\ t+7} *MCAP *INV *BM *MONTH\ (ESG_{it-1} \geq \gamma_1) + \text{FE} + e_{it} \quad (24)$$

Variables:

$R_{it,\ t+7}$: The dependent variable. Log return for company i for day t to day t+7

$R_{Mt,\ t+7}$: Log return of the S&P500 index for day t to day t+7, used as a market return reference

ESG_{it-1} = The threshold variable. ESG score of company i in year t-1

MONTH = Regime-dependent variable. A sequential numeric variable where each number corresponds to a consecutive month, starting with the value of 1 for the first month in the dataset.

MCAP = Log of market capitalization in year t-1

INV = The investment rate calculated as ΔTotal assets$_{t-2}$/Total assets$_{t-3}$

BM = Book value in year t-2 divided by market capitalization in year t-2

FE : The individual fixed effects. This term captures all unobserved heterogeneity that could consistently affect the dependent variable over time but varies between firms.

e_{it} : The error term. It accounts for the random variation in monthly returns that cannot be explained by the model.

Two separate regressions will be conducted and compared.

Equations:

<u>High ESG</u>

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + e_{it} \quad (25)$$

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + e_{it} \quad (26)$$

$$R_{it,\ t+7} = \beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + FE + e_{it} \quad (27)$$

Low ESG

$R_{it,\ t+7}$= $\beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + e_{it}$ (28)

$R_{it,\ t+7}$= $\beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + e_{it}$ (29)

$R_{it,\ t+7}$= $\beta_0 + \beta_1 R_{Mt,\ t+7} + \beta_2 MONTH\text{-}3 + \beta_3 MONTH\text{-}2 + \beta_4 MONTH\text{-}1 + \beta_5 MONTH1 + \beta_6 MCAP + \beta_7 INV + \beta_8 BM + FE + e_{it}$ (30)

Variables:

$R_{it,\ t+7}$: The dependent variable. Log return for company i for day t to day t+7

$R_{Mt,\ t+7}$: Log return of the S&P500 index for day t to day t+7, used as a market return reference

MCAP = Log of market capitalization in year t-1

INV = The investment rate calculated as ΔTotal $assets_{t-2}$/Total $assets_{t-3}$

BM = Book value in year t-2 divided by market capitalization in year t-2

MONTH-3: Dummy variable taking the value of 1 when observation is between 24/11/2021-23/12/2021 and otherwise is 0.

MONTH-2: Dummy variable taking the value of 1 when observation is between 24/12/2021-23/01/2022 and otherwise is 0.

MONTH-1: Dummy variable taking the value of 1 when observation is between 24/01/2022-23/02/2022 and otherwise is 0. The last month before the war.

MONTH1: Dummy variable taking the value of 1 when observation is between 24/02/2022-23/03/2022 and otherwise is 0. The first month after the war.

FE: Firm fixed effects

e_{it} : The error term. It accounts for the random variation in monthly returns that cannot be explained by the model.

Table 8: High and Low ESG regression results for the second Robustness check

		High ESG			**Low ESG**	
	(25)	**(26)**	**(27)**	**(28)**	**(29)**	**(30)**
MARKET	0.9449*** (0.000) [0.006]	0.9452*** (0.000) [0.005]	0.9383*** (0.0000) [0.0057]	1.0129*** (0.000) [0.005]	1.0125*** (0.000) [0.005]	1.0055*** (0.0000) [0.0047]
MONTH-3	0.020*** (0.000) [0.000]	0.0020*** (0.000) [0.000]	0.0015*** (0.0000) [0.0003]	0.0002 (0.304) [0.000]	0.0002 (0.344) [0.000]	-0.0003 (0.2754) [0.0002]
MONTH-2	0.0030*** (0.000) [0.000]	0.0029*** (0.000) [0.000]	0.0032*** (0.0000) [0.0004]	0.0019*** (0.000) [0.000]	0.0019*** (0.000) [0.000]	0.0023*** (0.0000) [0.0004]
MONTH-1	0.0006 (0.495) [0.000]	0.0006 (0.117) [0.000]	0.0012*** (0.0018) [0.0004]	0.0028*** (0.000) [0.000]	0.0028*** (0.000) [0.000]	0.0034*** (0.0000) [0.0003]
MONTH1	-0.0015*** (0.000) [0.000]	-0.0014** (0.017) [0.000]	-0.0003 (0.4409) [0.0004]	-0.0014*** (0.000) [0.000]	-0.0014*** (0.000) [0.000]	-0.0007* (0.0548) [0.0004]

MCAP		0.0307 (0.722)	-0.0127*** (0.0000)		-0.0008*** (0.000)	-0.0117*** (0.0000)
INV		-0.0027*** (0.000)	-0.0014** (0.0110)		-0.0007*** (0.000)	-0.0002 (0.2536)
BM		0.0112* (0.077)	-0.0093 (0.7929)		-0.0662*** (0.000)	-0.0179 (0.7293)
TH-1	71.1 (0.1767)	71.1* (0.0846)	71.1* (0.0767)	71.1 (0.1767)	71.1* (0.0846)	71.1* (0.0767)
FE	No	No	Yes	No	No	Yes
R^2	0.272	0.272	0.2751	0.259	0.260	0.2627
N	93626	93626	93626	164324	164324	164324

Table 8 present the regression results for high and low ESG using the equations from (25) to (30). RETURNS measure weekly returns. MARKET represent the weekly market returns, proxied by the S&P500 index. ESG scores are provided by Refinitiv (ESG) and were collected in year t-1. MCAP is the logarithm of market capitalization in year t-1. INV is the investment rate as defined by (Fama & French, 2015). BM is the book value (common shareholder’s equity) in year t-2 divided by market capitalization in year t-2. MONTH-3 represent the month from 24/11/2021 to 23/12/2021. MONTH-2 represent the month from 24/12/2021 to 23/01/2022. MONTH-1 represent the month from 24/01/2022 to 23/02/2022. MONTH1 represent the month from 24/02/2022 to 23/03/2022. In parenthesis the p-values are presented and, in the brackets, the standard errors are reported. Row TH-1 shows the estimation of the threshold (γ_1) of equations (22), (23), (24). In the parenthesis the p-values of the single threshold effect test is reported, employing a bootstrap method with 300 replications. * , ** , *** indicate the significance levels of 10%, 5% and 1%.

The first robustness check enhances the trustworthiness of the main findings of the thesis, revealing heightened abnormal returns for the Low ESG regime, in the last two months before the war. Prior to this, the High ESG regime had accumulated greater excess returns compared to the Low ESG firms. The first three months following Russia's invasion of Ukraine, the two regimes performed similarly.

Hypothesis 1 of the study is confirmed using weekly returns with 90% confidence using the equations (23) and (24) as a single threshold presence at 71.1 can be accepted. However, the hypothesis is not confirmed using the equation (22).

The second robustness check shows that in the last two months before the war both regimes outperform the market. However, during the first month after the war, High and Low ESG companies experienced negative abnormal returns. During the month from 24/11/2021 to 23/12/2021, High ESG firms demonstrate significantly greater abnormal returns than Low ESG firms, aligning with previous findings. Excess returns for the Low ESG group, appear to be significantly higher than those for the High ESG group only in the month preceding the invasion. Therefore, the effect of the war on Low and High ESG companies appear to be more temporary compared to its impact on monthly returns.

Limitations and Assumptions

Limitations

The available of financial data and ESG rating quality and breadth pose a significant impact on the findings within the study. However, certain databases provide exhaustive data albeit coverage limitations; especially small, unknown companies (Agyei, 2023). The thesis collect data about the companies listed in the S&P 500 to cope with that issue but this approach might constrain the generalizability of the results by relating the threshold value predominantly to larger companies in the US.

Reliability and consistency of ESG ratings are important. There are differences in methodologies used by different ESG rating agencies, which may result in inconsistencies. Standardizing ESG performance, however, is problematic due to the variable nature of ESG across companies and various sectors (Ahmad et al., 2021). Consequently, it will be advantageous if ESG data were also collected by other agencies to further robust the derived results.

There are numerous other factors affecting the stock market apart from the Russia-Ukraine conflict and ESG ratings. Market volatility, economic policies, investor sentiment and global demand requirements are also important determinants of stock prices (Dixon et al., 2020). However, the isolation of the effects of the Russia-Ukraine war and ESG ratings from these factors remains challenging.

Especially regarding the defense sector, the findings of this study may not be able to be generalized across different geopolitical contexts. In this regard, the distinctive nature of the defense industry in periods of conflict may preclude generalizations to broader market dynamics (Caldara and Iacoviello, 2022).

Assumptions

Analysis is not conducted for any particular investment because of the assumption in market efficiency whereby all available information is being reflected in stock prices. However, during high uncertainty periods and generally in real-life situations, this assumption may not be true.

The study assumes that investors are rational and make decisions based on the information they have. But there are psychological aspects that can affect the behaviour of the investor and thus decisions deviate from reasonable expectations (La Torre et al., 2020).

The analysis presupposes uniformity of financial and ESG reporting rules applicable in various companies and regions. Nevertheless, there also exist differences in the reporting practices that can decrease data comparability (Brown, 2011).

This research supposes that the Russia-Ukraine conflict had a direct impact on global markets and ESG stock returns. Although this is probably the case, geopolitical events are so intricate and multifold that their impacts may become ambiguous.

Conclusion

The study analyzes the impact of the Russia-Ukraine war on US stock returns, highlighting the differential effects on companies associated with High vs Low ESG (Environmental, Social and Governance) score. The relevance of this study is based on its examination of ESG investing and geopolitical risks against the backdrop of current international financial prospects. The findings reveal conditional advantages of High ESG scores rather than uniform sustainability throughout the period under investigation. Importantly, Low ESG firms experienced a surge in excess returns in the months preceding the war. As the conflict ensued, the trend gradually disappeared or even reversed. The thesis aims to add insights regarding the ESG investing sustainability in times of geopolitical tensions comparable to the Russia-Ukraine war. It is underlined that ESG investing can be complex as the sustainability that the High ESG scores offer, depends on external factors.

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