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The impact of the Russian-Ukraine war on German stocks: An event study

Author: Thomas Rottier
Student number: 544350
Thesis supervisor: Ruben de Bliek
Second reader: Sipke Dom
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ABSTRACT

In this thesis, I study what the effect of the invasion of Ukraine by Russia on the German stock market and individual industries is. This is done by performing an event study using daily stock prices of German firms active on the Xetra exchange. The expected returns are calculated using the market model, from which abnormal returns are determined. The effect on the German economy is determined by a t-test on (C)AAR and the effects on industries are determined using an OLS-regression. The effect on the whole economy is negative. On industry level, the consumer cyclicals and finance sectors endured the biggest hit, and the energy sector profited from the war.

Keywords: Event Study, Russia-Ukraine war

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CHAPTER 1 Introduction

The trade turnover between Germany and Russia is a fundamental factor in the formation of trade relations for European countries (Smirnov et al, 2019). In 2020, Russia supplied about 40% of Germany's natural gas imports and Russia was Germany's 14th largest trading partner, accounting for 2% of its total exports and 1.3% of its total imports (OEC.world). However, in the early morning of the 24th of February 2022, their trade relations took a heavy hit. Russia invaded eastern Ukraine. It did not take long for many companies to stop operations in Russia. More than 1900 companies withdrew, scaled back, suspended, or paused their investments, with over 200 companies exiting completely (leave-russia.org). When a lot of companies leave a certain country all at once, this can't be good for the overall economy, right?

The impact of geopolitical conflicts on financial markets has been a topic of research for a long time, with studies varying in their conclusions. For example, Brune et al (2015) find that the war likelihood tends to decrease stock prices, with the ultimate outbreak actually increasing stock prices. In case of a war that starts as a surprise, stock prices tend to decrease. In contrast, Zhang et al (2022) find that an increase in daily geopolitical risk leads to an increase in returns and volatility for global defense and aerospace companies. Previous research by Qureshi et al (2022) shows that financial sectors consider that political effort of Ukraine have deteriorating effect on the conflict, which induce instability in the Western economy. Research by Boungou & Yatié (2022) confirms this, as they show that the impact several weeks after the invasion on the global stock market was significantly negative. Stock prices of geographically nearby countries were affected more than those of distant countries, which makes Germany interesting to study. Covering a period from 1997 to 2021, Adebayo et al (2022) researched the influence of geopolitical risk (GPR) on the South Korean stock market. They found that GPR has a causal influence on the stock market. Salisu et al (2021) come to the same conclusion, stating that GPR is a significant predictor of stock returns, but they also state that threats of GPR cause greater effects than the actual occurrence. In my research these statements could be confirmed.

This paper will try to answer the question: What has been the effect of the Russia-Ukraine conflict on German stocks? To the best of my knowledge, this problem has not been addressed before in the literature. Some studies have covered the impact of the conflict on the American stock market, but not on the European market. Germany is the most interesting country to study the impact on, since Germany is one of the biggest European economic powerhouses and one of the biggest trading partners of Russia. Since Russia attacked Ukraine, the EU has put many sanctions on trade with Russia, which directly affect German law. For example, banks, insurance companies and other economic operators are obligated to freeze Russian assets. Marcel Fratzscher, a German economist and professor at Humboldt-University of Berlin, stated that the Russia-Ukraine war cost the German economy over 100 billion euros in 2022, equivalent to 2.5 percent of their total economic output.

Close to 55% and 35% of all natural gasses and crude oil respectively in Germany were supplied by Russia before the war began (Simsek, 2023). Therefore, it is highly important to understand the consequence such a war has on a country that is not participating, but is reliant on a country that is. Besides figuring out the effect on the whole German economy, this paper also divides the economy into different industries and try to find out which industries have been affected the most. Given the lack of empirical evidence on the effect of the Russia-Ukraine conflict on German stock prices, this research aims to fill the gap in the literature.

To answer these questions, this paper will compare the expected stock prices of German stocks with the actual stock prices. After comparing, the dependent variable will be cumulative abnormal returns, calculated from abnormal returns. This is measured by subtracting the expected return from the actual (or realized) return. The expected return will be calculated by averaging the return observed in the past and individualizing these by firm using the beta. According to Warner & Brown (1985), this can be done because returns follow a random walk. They even suggest that investors can make profitable investment decisions by analyzing returns of an asset to predict future returns. For control variables, certain fundamental factors will be chosen, like net profit margin, return on equity and total asset turnover (Martani et al. 2009).

This paper will use data for German stock exchange traded companies to answer the questions above. The data used is daily stock prices from all German stocks on the Xetra exchange. The market index will be the Deutscher Aktieindex (DAX), which measures performance of the 40 biggest German exchange traded companies on the Frankfurt Stock Exchange – accounting for over 80 percent of the total market capitalization. Daily stock prices from three days before the announcement of the war to three days after the announcement are used for the event window, and the estimation window will include stock prices up to 120 days before the invasion. The estimation method used to calculate expected returns in this paper will be Ordinary Least Squares (OLS), which will be used in STATA.

Secondary data on German stock prices is subtracted from Eikon at the Data Center Erasmus on campus. Eikon has access to daily price changes for all German stocks and all sorts of financial data like profitability and book-to-price ratios. The period needed is roughly a month before the war until one year after the war started. Meaning, from January 2022 to March 2023 – from two months before the war, to one year after the day that Russia invaded Ukraine. That is because this paper tries to measure the impact of the war on the days surrounding the outbreak of the war and a year after the conflict started. These outcomes will be compared to the expected stock returns.

My expectation for this research is that overall, the impact of the Russia-Ukraine war has a significant negative effect on the German stock prices, in line with the research by Boungou & Yatié (2022). On industry level, my expectation is that firms active in the commodities and gas market experience a greater hit on their stock prices, as firms active in other industries.

The remainder of this paper is structured as follows. Section 2 discusses relevant literature and previous research. Section 3 dives deep into the data collected for the research. Section 4 discusses the methodology used to calculate the expected and abnormal returns, significance tests and the OLS-regression. Section 5 shows the results of the hypothesis and the individual effects per industry, section 6 concludes the thesis and section 7 discusses the flaws of this study and ideas for future research.

CHAPTER 2 Theoretical Framework

This paper will look into literature on political risk, spillover effects and war affecting financial markets. For both political risk and spillover effects, a definition is given at the start of the paragraph.

2.1 Political Risk

Political risk refers to the risk of an investment being affected by political factors such as government policy, political instability, or regulatory changes. This paper explores theories related to how investors perceive and respond to political risk and how this may have influenced the stock prices of German companies during the conflict.

To start off, conflicts and political risk are in line with each other. The difference we are inclined to know has to do with the difference between political risk and political uncertainty. As pointed out by Yoav J. Tenembaum (2012), risk is tangible; uncertainty is not. He brings up a clear example of the difference between the two: the rise of the Nazi party in Germany in 1933 has considered an uncertain event, as the world was not sure in which direction the Germans would go. Later, the invasion of Poland on the 1st of September 1939, caused other governments to identify the Third Reich as a political risk. For the literature research in this paper, only political risk is considered. That is because the invasion of Ukraine is in line with the example above and the invasion should be recognized as political risk rather than uncertainty.

Although we can distinguish between economic and political determinants of events, they are obviously related. One could say that politics largely determines the framework of economic activity. This is confirmed by Kobrin (1978), who concluded that political conflict has the highest probability of affecting foreign investors when it occurs under conditions which motivates changes in government policy – which the Russia-Ukraine conflict most certainly did.

We start off with papers covering the political risk of conflicts on financial markets. For example, Carter and Simkins (2004) study the impact the terrorist attack in New York on 9 September 2001 had on firms and found abnormal negative returns for airlines and airfreight firms. Aktas and Oncu (2006) study the influence of the rejection of the deployment of American troops in Turkey by the Turkish parliament on the Turkish stock market. They find that this political event has a significant negative effect on Turkish stock prices, with a decline in stock returns in the days following the rejection. Beaulieu, Cosset and Essaddam (2005) study the impact of the possible separation of Quebec from Canada on the volatility of stock returns. They find that political risk is diversifiable, and that stock return volatility varies with a firms' exposure to political risk – in other words, companies that face higher levels of political risk often assume the responsibility of diversifying their operations. Vally Koubi (2005) studied the relation between war and economic growth for several countries from 1960 to 1989. He used a method that divides the timespan of a war into three periods: the prewar, the contemporaneous period and the postwar period. He concluded that countries close to the war are

affected negatively for all periods. Another conclusion he made is that cross-country differences in economic growth are related to the duration and severity of the war.

Wars have much bigger impact on a country compared to terrorist attacks – not only on the safety of the citizens, but also on a country's economy. Frey and Kucher (2000) used bonds denominated in Swiss francs to see whether historic events during the Second World War affected bond prices, for the countries Germany, Austria, France, Belgium, and Switzerland. They found that the German invasion of Poland had a big negative impact on all the country's bond index – except for Switzerland. Investors considered it more likely that the Swiss government would be able to service their debt than any of the other countries. Also, the German invasions of Austria, France and Belgium affected the respected country's bond index negatively. Hudson and Urquhart (2015) studied the impact of World War Two on the British stock market. They found a negative link between war and stock market returns. However, they did also find a significant negative announcement day effect, like studied by Akhtar et al. (2011). That is because investors are subject to sentiment (DeLong et al. 1990). Investor sentiment is defined as a belief about future cash flows and investment risks that are not defined only by fundamental factors – mostly by emotions and perceptions. Most notably, investor sentiment can contribute to market inefficiencies, because stock prices can differ from their fundamental value because of it (Baker and Wurgler, 2007).

2.2 Spillover Effects

A spillover effect of war refers to the unintended consequences and impacts that extend beyond the borders of the initial conflict zones, affecting neighboring regions and/or the global community. These effects can come in different ways, for example as a displacement of populations, spread of violence into adjacent areas, economic disruptions, and political instability. Bassel F. Salloukh (2017) studied the spillover effects of the war in Syria for Lebanon. In the winter of 2017, over one million Syrian refugees were officially registered in Lebanon, with an estimation of half a million extra unregistered. The costs for these refugees are roughly $4.5 billion per year, according to the World Bank. Small crimes have increased by 60 percent since 2011. The war has led to a significant decline in Lebanon's economic growth and overall economic performance. This is because of a disruption in trade routes, decreasing investments, and reduced tourism. These negative effects have caused an increase in unemployment and poverty in the country – mostly affecting vulnerable populations. The Lebanese government struggles to meet social demands, like education and healthcare. Finally, the economic instability has caused inflation and a very volatile exchange rate, straining the purchasing power of Lebanese citizens. Senior Economist Olaf J. de Groot (2010) examines spillover effects of conflict in Africa. He finds two opposing effects: a positive and a negative one. The negative spillover effect is the same as described by B. F. Salloukh (2017) for Syria, however, the positive spillover effect adds something new. De Groot concludes that armed conflict can

also generate positive spillover effects on neighboring countries. For example, new resource reallocation, increased demand for goods and services relation to the conflict, and presence of international aid and investment. These factors can stimulate economic activity and contribute to higher growth rates in neighboring countries. Lastly, Richard L. Millet (2002) investigates the impact of the conflicts in Colombia – namely social and economic inequality, political violence, and drug trafficking – on several neighboring countries. For Venezuela, the spillover effect contains an increase in security costs, strained relations affecting trade and investment, disruptions in border regions, and the burden of hosting many Colombian refugees – all effecting the Venezuelan economy negatively. For Peru, the presence of guerrilla activities and the potential for armed conflict along the border can create security risks and disrupt economic activities, affecting Peru's reputation as an investment destination. Cross-border trade is negatively affected, with the only upside being a decline in cocaine trafficking. Ecuador suffered the same negative effects, on top of their own internal economic and political difficulties, making it more difficult to effectively respond to the situation. To conclude, Brazil. While Brazil's large size contributed to lesser direct impacts for Colombia's conflicts, the issues of narcotics trafficking and border security remained significant concerns for Brazil's nation security and stability.

The spillover effect of the Russia-Ukraine war on Germany has been multifaceted and significant. The conflict has had a direct impact on the German economy, particularly due to its strong trade ties with both Russia and Ukraine. Germany, being a major player in the European Union, has experienced disruptions in its supply chains, decreased export opportunities, and uncertainty in energy markets, as Russia is a key supplier of natural gas and crude oil to Germany. Additionally, the influx of Ukrainian refugees seeking safety in Germany puts a strain on the country's resources, including social services and infrastructure. These spillover effects highlight the connection between nations and demonstrate how conflicts in one region can have far-reaching consequences for foreign countries, impacting their economy, social fabric, and political landscape.

2.3 The Effects of War on Financial Markets: Ukraine-Russia conflict

In response to Russia's military aggression against Ukraine, the European Union has expanded sanctions against Russia by adding a significant number of persons – like Vladimir Putin - and entities to the sanction list, and by adopting restrictive measures. Measures are taken to weaken Russia's economic base, for example significantly restricting access to the EU's capital and financial markets and services, closure of the EU airspace for all Russian aircraft, and prohibition of importing commodities from Russia. This not only has an effect on Russian firms, but also on non-Russian companies. Other research on the effects of the conflict in Ukraine is discussed.

In 2022, the same method of dividing a war into three periods as used by Valley Koubi (discussed in 2.1) was used by Deng, Leippold, Wagner and Wang, who studied the impact of the Russia-Ukraine war on global stocks. Average equity returns for all firms in the countries researched

were negative in the contemporaneous and postwar periods. The main finding was that companies from countries like Canada and the USA had a positive postwar period, in comparison to French, Italian, German and other European-based firms, who had a negative postwar period. So, geographically close countries to the area of war are affected more than others. Mbah and Wasum (2022) state that the crisis in Ukraine will extend to the global economy. That is because Russia is the export leader for commodities like crude oil, gasses, and coal. If Russia decides to restrict its exports, global commodity prices will skyrocket, negatively impacting the global economy. This is confirmed by Adekoya et al (2022), since they conclude that oil is the main reason for all shocks in other countries. The impact of the war on the commodity market is also studied by Umar et al. (2022), who say the war has adversely affected the energy sector. "The war appears to have prompted a boom in the stock values around the world, particularly in the renewable energy sectors." This only is the case for this sector, however, as Boungou and Yatié (2022) find that ninety-four countries experienced negative stock returns because of the war. Sun et al (2022) evaluate the reaction of the global stock market on the announcement of the invasion. They conclude three things: first, stocks of adjacent countries to both Russia and Ukraine are negatively affected, because of geopolitical risk. Second, finance and services sectors are affected more than manufacturing countries in Europe. Lastly, oil and gas companies outside of Europe experience positive abnormal returns, in line with the paper by Umar et al. But again, stock prices of companies in this sector that are located near Russia or Ukraine are affected negatively. Yousaf et al (2022) basically study the same topic, however, they look at the reaction of the G20 countries stock markets. These countries hold 90% of the gross world product and they are involved in around 75% of international trade. Their conclusion is in line with the paper of Sun et al: European and Asian countries (in other words, adjacent to Russia or Ukraine) are affected significantly and negatively. They also found that the stock markets of Hungary, Russia, Poland, and Slovakia reacted faster than other countries. Countries like Australia, France, India and South Africa were affected positively post-invasion.

These papers lead us to the following hypothesis:

The announcement of Russia invading Ukraine on the 24th of February 2022 negatively affected German stock prices.

CHAPTER 3 Data

To understand what the impact of the war has been on German stock prices, a sample is taken from the German exchange – namely, the biggest stock exchange of the country: the Xetra exchange. The Xetra exchange is an electric stock exchange, owned by the Deutsche Börse Group, who also own the Frankfurt Stock Exchange. This exchange is the largest of the seven stock exchanges in Germany, accounting for around ninety percent of total stock transactions in the country. The total market capitalization of firms listed in Germany on this exchange on the 31st of December 2022 amounted to a 1.74 trillion euros (statista.com), just short from their peak of 2.21 trillion euros on the same date in 2021.

Data is retrieved from the Revinitiv Eikon class at the Erasmus Data Service Centre in Rotterdam, Netherlands. The Refinitiv Business Classifications (TRBC) per firm are retrieved. The different sectors are in line with Fama & French (2022). See table 1 for an overview of the sectors and the number of companies per sector. In total the sample consists of 385 different firms. In total, 489 firms are active on this exchange, however, Revinitiv Eikon only had access to 411 daily firm prices over the period below, and 26 of those firms had incorrect company fundamentals – for example, net profit margins over 100%.

Table 1. Frequencies per industry

Industry	Freq.	Percent	Cum.
1. Basic Materials	26	6.77	6.77
2. Consumer Cyclicals	55	14.32	21.09
3. Consumer Non-Cyclicals	12	3.13	24.22
4. Energy	9	2.34	26.56
5. Financials	52	13.54	40.10
6. Healthcare	28	7.29	47.40
7. Industrials	62	16.15	63.54
8. Real Estate	28	7.29	70.83
9. Technology	101	26.30	97.14
10. Utilities	11	2.86	100.00
Total	**384**	**100.00**	

Notes: The industries are based on the Refinitiv Business Classifications (TRBC). Freq. stands for the number of firms per industry; Percent shows the percentage of the total; Cum. stands for the cumulative percentage.

Next, time series data is also retrieved from the Revinitiv Eikon class. This paper will use an estimation window in line with research by MacKinlay (1997), who states that an event using daily data should use an estimation window of 120 days. The event position E_0 is equal to the 24th of February 2022 – in the early morning of this Thursday Germany became aware of the news that Russia invaded Ukraine. The event window consists of 7 days, from E_{-1} ($E_0 - 3$) to E_1 ($E_0 + 3$). This means that the estimation window is from E_{-2} ($E_0 - 123$) to $E_0 - 4$. Let's call the length of the estimation window L_1 and the length of the event window L_2. Only trading days are considered.

Finally, company fundamentals are retrieved from the Revinitiv Eikon class as well. Because there were only 385 companies that Revinitiv Eikon had access to for company fundamentals, 26

companies are being dropped from the dataset. See table 2 below for the descriptive statistics of all (in)dependent variables. The dependent variable Cumulative Abnormal Return (CAR) is checked for outliers. If outliers are present, these should be investigated and excluded, since these outliers could be providing misinformation. The company Medigene had a daily return of 92% on the 25th of February 2022, so this company is eliminated from the database. The control variables are all company fundamental ratios. The net profit margin (NPM) is equal to a company's net income divided by their total revenue. Return on equity (ROE) is simply dividing a company's net income by its average shareholders' equity (assets minus liabilities). Since the equity can fluctuate during our estimation and event window, an average shareholders' equity is used. Finally, the asset turnover ratio ($TATO$) is equal to net sales divided by the total assets of a company.

Table 2. Descriptive Statistics

Variable	Obs	Mean	Std. Dev.	Min	Max
CAR	384	-.598	8.63	-32.749	55.472
NPM	384	.06	.212	-1.636	.998
ROE	384	.092	.233	-1.537	1.029
TATO	384	.85	.703	.01	7.63

Notes: CAR, NPM, ROE and TATO are all ratios.

CHAPTER 4 Method

The methodology used in this study is inspired by the research done by J. Binder (1998), who summarized the event study methodology since 1969, and the thesis by R. Meursing (2022), who investigated the effects of the Russia-Ukraine war on US-listed stocks using abnormal returns. This includes both the measurements as the statistical analysis of abnormal returns.

4.1 Event Study

Normal returns will be calculated based on the estimation window [L_1] before the event window. These normal returns will be calculated using the following formula, also known as the market model:

$$E(R_{it}) = \alpha_i + \beta_i R_{mt} \quad \textbf{(1)}$$

R_{mt} here is the return of the Deutscher Aktienindex (DAX) on day t. The DAX contains 40 blue chips on the Frankfurt Stock Exchange, being a benchmark for German and European stocks. Well-known companies in this index are Volkswagen, BMW, and Adidas. The β_i is a parameter of the market model, better known as the beta of each firm i. Each beta can be calculated as follows:

$$\beta_i = \frac{\sum_{t=E_{-2}}^{E_{-1}} (R_{it}-\mu_i)(R_{mt}-\mu_m)}{\sum_{t=E_{-2}}^{E_{-1}} (R_{mt}-\mu_m)^2} \quad \textbf{(2)}$$

$$\text{where } \mu_i = \frac{1}{L_1} \sum_{t=E_{-2}}^{E_{-1}} R_{it} \quad \textbf{(3)}$$

$$\text{and } \mu_m = \frac{1}{L_1} \sum_{t=E_{-2}}^{E_{-1}} R_{mt} \quad \textbf{(4)}$$

Actual daily returns are calculated using the closing prices on day t and $t-1$:

$$R_{it} = \left[\frac{P_{it} - P_{it-1}}{P_{it-1}}\right] * 100 \quad \textbf{(5)}$$

Where P_{it} stands for the closing price of stock I on day t.

Abnormal returns are derived using the expected and actual returns, see formula below:

$$AR_{it} = R_{it} - E(R_{it}) \quad \textbf{(6)}$$

Where AR_{it} stands for the abnormal return of stock i on day t.

The cumulative abnormal returns are equal to the sum of all abnormal returns of stock i over the event window [L_2]:

$$CAR_i = \sum_{t=E_{-1}}^{E_1} AR_{it} \quad \textbf{(7)}$$

The common reaction on day t of all stocks to the event is known as the aggregate abnormal return:

$$AAR_t = \sum_{i=1}^{N} \frac{AR_{it}}{N} \quad \textbf{(8)}$$

Where AAR_t is equal to the aggregate abnormal return on day t and N is the total number of stocks. If analyzed on the event day E_0, the effect of the event on the stock market will be shown. The AAR_t is used to calculate the cumulative aggregate abnormal return ($CAAR$) over the event window [L_2].

$$CAAR = \sum_{t=E_{-1}}^{E_1} AAR_t \quad \textbf{(9)}$$

4.2 Significance Tests

To see whether the event has had any significant effect on stock prices, we need to test the significance of both AAR_t and $CAAR$. This is done by using the cross-sectional t-test, which is often used in event studies where an event has had a significant effect on the returns of a group of stocks. To start off, the null hypothesis $H_0: E(AAR_t) = 0$ can be tested using the following equation:

$$t_{AAR_t} = \sqrt{N} * \frac{AAR_t}{\sigma_{AAR_t}} \quad \textbf{(10)}$$

Where σ_{AAR_t} is equal to the standard deviation of all stocks on day t, so:

$$\sigma^2{}_{AAR_t} = \frac{1}{N-1} \sum_{i=1}^{N} (AR_{it} - AAR_t)^2 \quad \textbf{(11)}$$

The next step is to find the p-value for every t-statistic to test the null hypothesis, to conclude that the event had a significant effect on returns.

Next is the null hypothesis $H_0: E(CAAR) = 0$ which lets us know if the event is significant for all firms over the entire event period $[t+3, t-3]$:

$$t_{CAAR} = \sqrt{N} * \frac{CAAR}{\sigma_{CAAR}} \quad \textbf{(12)}$$

Where σ_{CAAR} is equal to the standard deviation of all stocks during the event window:

$$\sigma_{CAAR} = \left(\sum_{t=E_{-1}}^{E_1} \sigma^2{}_{AAR_t} \right)^{1/2} \quad \textbf{(13)}$$

4.3 Regression Analysis

Besides looking at the impact of the event on the whole German stock market, it is also interesting to see what industries have been impacted more than others. This is done by analyzing the regression below. In the regression the independent variables are industry dummies and company fundamentals. The company fundamentals needed are based on the research by Martani et al. (2009), who found that profitability ratios like $Net\ profit\ margin$ (NPM) and $Return\ on\ equity$ (ROE), and the turnover ratio $Total\ asset\ turnover$ ($TATO$) all are consistently significant on (abnormal) return.

$$CAR_i = \beta_0 + \beta_1 NPM_i + \beta_2 ROE_i + \beta_3 TATO_i + \sum_{k=2}^{10} \beta_{k+4} industry_{ki} \quad \textbf{(14)}$$

In the regression, the constant β_0 captures the effect of industry "*Basic Materials*" since we need a reference category for our dummy variable. All company fundamental variables should eliminate the chance of omitted variable bias, since these variables explain the abnormal return of the firms mostly. Since this regression uses cross-sectional data, clustered errors are used if the errors are in fact correlated. Unfortunately, this can't be checked, so the assumption must be made that there is no correlation between the errors. Next, the assumption that individual abnormal returns are independent and identically distributed must be made. Later two tests on homoskedasticity are performed. This is needed since homoscedasticity is necessary to get accurate standard errors for our estimates. The tests performed will be the Breusch-Pagan test against heteroscedasticity – non-constant variance, and the White test. If the test results in a small p-value, the residual variance is non-constant. Therefore, robust standard errors are used in the regression.

CHAPTER 5 Results & Discussion

This chapter presents the outcomes from testing the two propositions put forward to address the primary research questions. Each subsection reports the findings corresponding to the hypothesis.

The hypothesis was about the overall impact of the Russian invasion of Ukraine on the German stock market. Subsection 5.1 will contain the impact on the German stock exchange Xetra as a whole, and subsection 5.2 will dive deeper by looking into the results of performing a regression on all different industries.

5.1 Event study analysis

In table 3, the results of the one-sample t-test on aggregate abnormal returns (AAR) per event day in the event window are shown. Apart from the day before the event, all days are significant on 1% level. This indicates that the days surrounding the beginning of the war, investors and shareholders were somewhat informed about the tension between Russia and Ukraine, but not totally sure what direction this tension would lead the global stock market into. On the event day itself, the average abnormal return was equal to -2.1%, indicating a strong significant negative reaction to the news. From this point forward, the standard errors have increased from around 0.13 to 0.16-0.23, which indicates that the stock market volatility has increased because of uncertainty (Schwert, 1989). The day after the Russians invaded Ukraine, the average abnormal return was 3.3%, a significant increase. This could be seen as a recovery. The initial negative effect represents an overreaction to the news of the war, with the following positive effect representing a correction as investors take advantage of discounted prices. This is in line with a study done by Barber & Odean (2008), who find that individual investors are influenced by attention-grabbing events or news. The second day after the news broke, abnormal returns are equal to 0.96%, another significant increase. The last day of the event window, day three, the abnormal returns are equal to -1.56 percent: a significant decrease. All in all, we can conclude that the start of the war in Ukraine has led to a significant decrease in German stock prices, and we can accept the first hypothesis. The result as discussed above is in line with the result from the study done by Boungou & Yatié (2022), who investigated the impact of the war on the global economy. They also found a negative effect both before and post-war (table 3, page 8).

Table 3. One-sample t-test for Abnormal Returns across the Event Window

Day	Obs.	AAR	St. Err.	t-value	p-value
-3	383	-1.222643	0.1337524	-9.1411***	0.0000
-2	383	-0.3495043	0.1302213	-2.6839***	0.0076
-1	383	0.3233895	0.1327433	-2.4362**	0.0153
0	383	-2.101054	0.1771643	-11.8594***	0.0000
1	383	3.343355	0.1554256	21.5110***	0.0000
2	383	0.9636261	0.2256431	4.2706***	0.0000
3	383	-1.555093	0.1705109	-9.1202***	0.0000

*Notes: AAR stands for the aggregate abnormal returns; t-value is the cross-sectional t-statistic; *** stands for significant at 1% level; ** stands for significant at 5% level; * stands for significant at 10% level.*

The Average Abnormal Returns (AAR) during the event window were found to be significantly different from zero, indicating a consistent daily effect of the event across all firms. The CAAR shows a consistent value of -2.583 across all firms for the event window, suggesting that the impact of the event accumulates over this period and is a negative effect on all firms' returns over the event window. In practical terms, this means that the event has led to a decrease in the value of German stocks. For investors, this indicates a decrease in their assets/investments, which could turn into losses if sold. On the bright side, investors could see this as a buying opportunity. For the firms, a decrease in returns makes it more difficult to attracts investors and to raise capital through issuing new shares. The overall market experiences a decrease in returns, which has led to an increase in market volatility. A robustness check with different event windows can be found in the Appendix, table Z.

Table 4. One-sample t test for CAAR with Event Window (-3,3)

	obs	Mean	St Err	t value
CAAR	2695	-2.583	0.022	-120.234***

*Notes: CAAR stands for cumulative aggregate abnormal return. *** stands for significant at 1% level.*

5.2 Regression analysis

Before performing an analysis on the regression to see the impact of the war on German stocks, a test on heteroskedasticity and multicollearity are a necessity.

To check if the error term is not constant across all levels of the independent variables, the White test and the Breusch-Pagan/Cook-Weisberg test are performed. The latter's Chi-square statistic is equal to 15.88 with a corresponding p-value of 0.0001. The result of the White test is a Chi-square of 359.66 for heteroskedasticity with a p-value of 0.0000. Therefore, the zero-hypothesis of constant variance and homoskedasticity can be rejected. Robust standard errors are therefore used in the OLS-regression.

Secondly, a test on multicollearity is needed. This is checked by a correlation table between the (in)dependent variables, and by performing the variance inflation factor (VIF) test for multicollearity between independent variables, both found in the Appendix (tables X and Y). The correlation matrix shows values between -0.1 and 0.1 except for one relationship: the correlation between net profit margin and return on equity, being 0.484. The VIF test for independent variables – measuring the (strength of) correlation between explanatory variables – gives a value to every variable, with a value of 1 indicating no correlation between the variable at hand an any other variable, and values greater than 5 indicating high correlation between the variable and other variables in the model. The highest VIF value of the regression is that of industry 9: Technology, with a value of 3.663. The mean VIF is 2.013. These results together with the results of the correlation matrix indicate that there is no multicollearity in the regression and the second zero-hypothesis is accepted.

In table 4, the results of the regression can be found. In total there were 383 observations made per day instead of the original 384, because one of the companies had missing data for the return variable, therefore not being part of this regression. Over the seven-day event window, 2681

observations are made. In the first model, control variables are left out. In the second model, three control variables are added. The differences between the two models are slim. The coefficients from model 2 of the industries did not drastically differ from those of model 1: the biggest difference is the rise by almost one unit-point by the *6. Finance* sector, and the significance of *7. Technology* at the 10 percent level. Since the second model takes control variables into consideration, from which two third has a significant impact on CAR, the results discussed below are related to the second model.

The model's R-squared on average was 0.10, meaning that 10% of the variance in the overall performance of the dependent variable cumulative abnormal returns for a given stock can be explained by all independent variables in the model. The study by Boungou and Yatié (2022) on the same topic but the effect on world stock markets, uses a regression as well and in their main regression – the impact before and during the war, for all periods – a R-squared of 0.017 is found (table 2, page 7). This means that our R-squared is in line with other event studies.

The interception is significant at 1 percent level with a coefficient of -4.34. So, there is a statistically significant baseline level of cumulative abnormal returns, even when all other variables are equal to zero. Because of the use of dummy variables, one industry had to be left out: *1. Basic Materials*. So, there is an effect caused by firms in this industry. The reference industry thus has a negative effect on CAR by 4.34-unit points. Ukraine was big on exporting metal, with total export of iron and steel above 13 billion US dollars in 2021 to a measly 4.56 billion in 2022 (Trading Economics 2023). This was foreseen by stock traders. Just like the *2. Consumer Cyclicals* sector, this industry is reliant on the economic weather.

The estimation coefficient for net profit margin is significant at the 5 percent level, suggesting that changes in NPM significantly impact CAR by on average -4.49-unit points if all other variables stay constant. Return on equity is highly significant on the 1 percent level, with a coefficient of 3.16 and a standard error of 0.97. This implies that – ceteris paribus – a one-unit increase in ROE is associated with an increase in CAR by approximately 3.16 units. Before moving on to the impact on different industries, the coefficient for total asset turnover is insignificant. The strong impact of particularly both NPM and ROE highlights the potential influence of the profitability on market reactions to outbreaks of wars.

Because the industry of a company is a categorical variable, the regression below needs a reference category, that will be 1. Basic Materials. If one of the other industries coefficients is positive, this means that its impact on CAR is more positive than that of the reference category. The same goes for a negative coefficient.

All but three industries are insignificant, namely *2. Consumer Non-Cyclicals, 7. Industrials* and *9. Technology*. The industry *7. Industrials* has the second highest concentration in the sample and *9. Technology* the highest, accounting for 16.15 percent and 26.30 percent of the total 384 firms, respectively.

The industry with the highest coefficient is the *4. Energy* sector, with a coefficient of 10.61. This coefficient is significant at the 1 percent level. Firms belonging to this industry on average experienced the cumulative abnormal returns more positively by 10.61 units, compared to firms in the *1. Basic Materials* sector. This can be explained by the fact that Russian energy firms were affected negatively by the outbreak of the war because of sanctions and major energy companies outside of Russia were affected positively because of the restrictions on competitors, as found by Deng et al. (2022).

Following *4. Energy* as an industry with a positive effect is *10. Utilities* with a coefficient of 7.74, also significant at the 1 percent level. This means that the *10. Utilities* sector experienced a 7.74 units bigger increase in CAR than the reference industry *1. Basic Materials*. Utility companies are mostly active in the supply of electricity & gas, water, sewage and other services to homes and businesses. Because there is some overlap in the energy and utilities sectors, the same conclusion can be made about this positive effect: Russian suppliers are no longer allowed to trade with German households and businesses due to sanctions, allowing German companies to charge more for their products or services.

Next is the industry *6. Healthcare*, with a coefficient equal to 4.16. This coefficient is significant at the 1 percent level. So, companies active in this industry experience an increase in CAR by 4.16-unit points more than the reference industry. If war breaks out in neighbouring countries, healthcare products and services are increasing in demand. An increase in exporting goods and providing services leads to an increase in revenues and profits, which leads to higher stock prices. Also, governments increase spendings on healthcare to help their allies.

The last industry which experienced a bigger rise in CAR than the reference sector, is the *8. Real Estate* sector. This sector has a coefficient of 3.76, significant at the 1 percent level. This means that the companies active in the *8. Real Estate* sector on average experienced an increase of 3.76 units in their CAR compared to the reference category. This can be explained by the fact that the *8. Real Estate* sector is seen as sort of a safe-haven investment. So, in times that the future of other companies is unsure, investors can always come back to investments that will most of the time payoff: housing.

The first industry with a significant negative CAR coefficient is *2. Consumer Cyclicals*, with an average decrease in CAR by 2.36 units, compared to the reference group. This coefficient is significant at 1% level. Consumer cyclical stocks are firms that heavily rely on economic conditions. Since in paragraph 5.1 the negative effect of the war on the German economy is shown, the conclusion can be made that this sector shows a decrease in cumulative abnormal returns as well.

The second and last negative effect is on the *5. Financials* sector, with a coefficient of -2.09, meaning that a financial firm on average had a decrease of 2.09 units in their CAR compared to the *1. Basic Materials* sector. Since the annexation of Crimea in 2013, many banks already decreased activities in Russia, however, there were still international banks present in Russia. Investment banking operations in Russia are heavily affected by sanctions, as these sanctions affect multiple

multinationals and oligarchs. Sun et al. (2022) find that the finance sector, along with the service sector, are affected by a greater degree than manufacturing firms, which is also found in these results below.

Table 5. Linear regression

	(1) CAR	(2) CAR
Consumer Cyclicals	-2.29***	-2.36***
	(0.72)	(0.74)
Consumer Non-Cyclicals	-0.79	-0.94
	(1.09)	(1.09)
Energy	10.77***	10.61***
	(1.13)	(1.15)
Financials	-2.51***	-2.09***
	(0.77)	(0.77)
Healthcare	4.29***	4.16***
	(1.26)	(1.11)
Industrials	-0.99	-0.93
	(0.82)	(0.83)
Real Estate	2.80***	3.76***
	(0.72)	(0.76)
Technology	1.24*	1.16
	(0.70)	(0.72)
Utilities	7.53***	7.74***
	(1.86)	(1.87)
NPM		-4.49**
		(1.79)
ROE		3.16***
		(0.97)
TATO		0.31
		(0.22)
Constant	-3.96***	-4.34***
	(0.64)	(0.71)
Observations	2681	2681
R^2	0.09	0.10
Adjusted R^2	0.08	0.09

Notes: Standard errors in parentheses
$^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$

CHAPTER 6 Conclusion

This paper studied the effect of the Russian invasion of Ukraine on the German stock market. This is studied by performing an event study with the event day being the 24th of February 2022, the day the invasion happened and the day that this became public knowledge. The event window used is three trading days prior to the invasion, to three trading days post invasion. German stock prices, the price of the DAX and company fundamentals are retrieved from the Revinitiv Eikon data centre at the Erasmus University in Rotterdam, Netherlands. From this data, the expected returns are calculated by multiplying the average market return during the estimation period by the calculated betas of each individual stock. The estimation period is equal to 120 trading days prior to the event window. With the calculation of the expected returns, abnormal, cumulative abnormal, aggregate abnormal and cumulative aggregate abnormal returns are calculated. Using a one-sample t-test, the overall effect on the German stock market is estimated. The overall effect on the German stock market over the chosen event window was estimated to be equal to -2.583, which is a significant negative effect on the 1 percent level. So, if the invasion never happened, stocks would approximately have a return of 2.583 higher than the return is now. After the estimation on the overall market, the effect on individual industries is estimated using an OLS-regression controlling for three company fundamentals that showed consistent significance in other event studies using abnormal returns (Martani et al. 2009). The results are in line with the literature review, as the finance sector had one of the biggest negative effects on CAR (Sun et al. 2022) and the firms active in the energy industry had the biggest positive effect on CAR (Umar et al. 2022).

It is important to study the effect of war on financial markets because wars have significant impact on economies. They can disrupt supply chains, influence governance spending, cause inflation, and impact interest rates, production, and productivity. The impact of war on stock markets causes market volatility because investors are not sure about the future (uncertainty). Understanding these effects can help investors and policymakers navigate in turbulent periods. Another reason to study specifically stock markets and not other financial markets is because of investors' beliefs about future business conditions. Effects of war are first seen on the stock market before they are shown in other economic data.

Besides the overall effects of war on global stock markets, it is important to dive deeper into the German stock market since Germany is the biggest economy in Europe – in fact, Germany has the fourth-largest economy in the world by GDP – and Germany imported many commodities from Russia. The Germans also play a significant role in the stability of the European Union, so this studying this impact could help the EU come up with future decisions.

To conclude, this paper examines the effect of the invasion of Ukraine by Russia on the German stock market and industries and finds a negative effect.

Chapter 7 Discussion

Many papers that studied the invasion of the Russians into Ukraine affecting financial markets, as discussed in *2.3 The Effects of War on Financial Markets: Ukraine-Russia conflict*, concluded that the general effect of this conflict has impacted the global economy negatively (Deng et al. 2022, Mbah & Wasum. 2022, Boungou & Yatié. 2022, Sun et al. 2022, and Yousaf et al. 2022). This finding is similar to the conclusion of this paper. Another paper discussed is that of Umar et al. (2022), who conclude that the energy sector experienced the opposite effect. From the results in table 5 this paper can conclude the same.

A point of improvement for this research could be two things: expanding the sample and improving the estimation of expected returns. To start off, the sample used in this study contains 385 firms from Germany. To investigate effects on industry level, it is important to have enough firms per industry. In this sample, there are three industries with less than 20 different firms. These industries are *3. Consumer Non-Cyclicals*, *4. Energy*, and *10. Utilities*. All three industries are significant at the 1 percent level, so these results could not be that representative for the global economy. The second point of improvement is the estimation of expected returns. In this paper the expected returns are calculated by first calculating every firm's individual beta and multiplying this by the daily market (DAX) return. To get a better estimation of the expected returns, more complex calculations can be used to get a better estimation.

For future research, it is important to understand the long-term effects of the war on national economies and the global economy. As of writing this paper, the war is in full effect, and it has been just over a year since the war has started. On the 17th of June 2023, Putin confirmed that the first nuclear weapons are being moved to Belarus, to combat an (unlikely) invasion of Russia (BBC.com, 2023) by Ukraine's allies. US Secretary of State Antony Blinken says: "We don't see any indications that Russia is preparing to use a nuclear weapon," but this of course could change in the future. Therefore, the impact of this war on global economy has to be studied for the long run, once time has passed.

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APPENDIX

Table X. Matrix of correlations

Variables	CAR	NPM	ROE	TATO
CAR	1.000			
NPM	0.020	1.000		
ROE	0.058	0.484	1.000	
TATO	0.039	-0.094	0.055	1.000

Notes: The values listed are fractions between -1 and 1, with -1 indicating perfect negative correlation, 0 indicating no correlation, and 1 indicating perfect positive correlation.

Table Y. Variance inflation factor

Independent Variable	VIF	1/VIF
NPM	1.41	.709
ROE	1.357	.737
TATO	1.244	.804
Consumer Cyclicals	2.722	.367
Consumer Non-Cyclicals	1.442	.693
Energy	1.328	.753
Financials	2.651	.377
Healthcare	1.955	.511
Industrials	2.895	.345
Real Estate	2.085	.48
Technology	3.663	.273
Utilities	1.409	.71
Mean VIF	2.013	.

Notes: a VIF of 1 indicates no correlation; a VIF between 1 and 5 indicates moderate correlation but not severe enough to require attention; a VIF greater than 5 indicates severe correlation.

Table Z. One-sample t-test for CAAR over different Event Windows

CAAR	obs	Mean	St Err	t-value
(-5,5)	2695	-2.583	0.022	-120.234***
(-10,10)	8085	-6.008	0.044	-135.559***
(-7,0)	3080	-0.652	0.042	-15.588***
(0,7)	3080	-2.444	0.052	-46.712***

Notes: the event day is equal to 0. The tested event window is in between the parentheses.
**** is a t-value significant at 1% level.*