THE INFLUENCE OF THE RUSSIA-UKRAINE WAR EVENTS ON THE FINNISH TECHNOLOGY INDUSTRY COMPANIES' STOCK PERFORMANCE

Lappeenranta–Lahti University of Technology LUT

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Examiners: Associate Professor, Sheraz Ahmed

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ABSTRACT

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Keywords: Russia-Ukraine war, stock market, technology industry, political risk

This study examines the influence of the Russia-Ukraine war events on the stock performance of Finnish technology industry companies. The aim is to increase understanding of the effects of the war, regarding the beginning of the war specifically for Finland but also beyond the first attack. This is pursued by studying multiple war related events, both military and non-military. Each event is studied separately by applying the market model of the event study methodology. The results are then compared to determine whether the event type impacts the market reaction. Since the war has continued to unfold, the stocks' long-term performance is also analysed through cumulative returns.

The results show the Russia-Ukraine war events have impacted the abnormal stock performance of the Finnish technology industry companies and other events than just the initial invasion have also caused market reactions. Furthermore, unlike generally in Europe, the outbreak of the war influenced investors of the Finnish industry immediately. The specific importance of the technology industry to the Finnish economy may explain the difference in investors' interpretation compared to Europe in general. Based on the results, both event types can influence the stock market positively and negatively, and there is no statistically significant difference in the impact on investors' decision-making between military events and non-military events. The long-term performance analysis suggests the challenges provided by the sanctions restricting trade with Russia have been long-lasting. The high-frequency nature of the war events influenced the reliability of the results and due to the specific objective of the study the results are not generalizable to other markets. Regardless, the results are indicative that the war has influenced the state of political risk in Finland and the uncertainty has been reflected in the development of the stock market.

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Tämä tutkielma tutkii Venäjän ja Ukrainan välisen sodan tapahtumien vaikutusta suomalaisten teknologiateollisuuden yritysten osakekehitykseen. Tavoitteena on lisätä ymmärrystä sodan vaikutuksista, kuten sen puhkeamisesta erityisesti Suomelle sekä ensimmäisen hyökkäyksen jälkeiseen aikaan liittyen. Ymmärrystä pyritään kasvattamaan tutkimalla useita, sotilaallisia sekä ei-sotilaallisia, tapahtumia. Jokaista tapahtumaa tutkitaan yksittäin tapahtumatutkimus metodologian markkina mallia hyödyntämällä. Tuloksia vertailemalla pyritään selvittämään erot tapahtumatyyppien välillä. Sodan yhä jatkuessa, myös osakkeiden pitkän aikavälin kehitystä analysoidaan kumulatiivisten tuottojen avulla.

Tuloksien mukaan Venäjän ja Ukrainan välisen sodan tapahtumat ovat vaikuttaneet suomalaisten teknologiateollisuuden yritysten osakkeiden epänormaaliin kehitykseen ja osoittavat, että ensimmäisen hyökkäyksen lisäksi myös muut tapahtumat ovat aiheuttaneet reaktioita markkinoilla. Sen lisäksi, toisin kuin yleisesti Euroopassa, sodan alkaminen vaikutti suomalaisen teknologiateollisuuden sijoittajiin välittömästi. Sijoittajien tulkinnan eroa muuhun Eurooppaan verrattuna voi selittää teknologiateollisuuden erityinen tärkeys Suomen taloudelle. Tulosten perusteella molemmat tapahtumatyypit voivat vaikuttaa osakemarkkinoihin sekä positiivisesti että negatiivisesti, eikä vaikutuksessa markkinoiden reaktioon ole niiden välillä tilastollisesti merkittävää eroa. Pitkän aikavälin kehityksen analyysin mukaan Venäjän kanssa tehtävää kaupankäyntiä estävien pakotteiden vaikutus yrityksiin on ollut pitkäkestoista. Tutkimuksen luotettavuutta heikensi tiheästi toteutuvat tapahtumat, eikä tuloksia voida myöskään yleistää koskemaan muita markkinoita tutkimuksen erityisen tutkimuskohteen vuoksi. Tästä huolimatta tutkimuksen tulokset indikoivat, että sota on vaikuttanut poliittisen riskin käsitykseen Suomessa ja sen aiheuttama yleinen epävarmuus on heijastunut osakemarkkinoiden kehitykseen.

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1 Introduction

The Russia-Ukraine war broke out on 24th of February 2022 when the Russian invasion of Ukraine occurred. Russia and Ukraine share a long history, and the situation between the countries had tightened throughout the years following the annexation of Crimea in 2014. Subsequently, unsettling developments preceded the invasion, indicative of the upcoming. (Shyam, 2023) Already in the spring 2021 Russia began to build up troops near Ukraine's border which was alleged to be a training exercise. Then again in November Russian forces were detected to build up near the border. At the end of the year Russia expressed its demands for NATO to withdraw forces from Eastern Europe and prohibited Ukraine to join the alliance. In the beginning of 2022, the fear of Russian attack on Ukraine grew after Russia indicated discontent that its demands had not been accounted for. After this, the US announced to strengthen forces in NATO member countries in Eastern Europe and threatened Russia of economic sanctions. Eventually, in February Putin authorized special military operations in Ukraine which launched the current conflict. (Reuters 2022)

The uncertainty of the situation was reflected in the Finnish stock markets as well. The price and return development of the OMXH25 index few months before the invasion until the end of the first year of the war can be observed in Figure 1. The graph shows that already around the time of the event in November, the volatility of the index price increased and there was a considerable drop in the return at the end of the month. Similarly, the turmoil in the market intensified towards the end of January 2022 resulting in an even more significant drop in the return. Towards the day of the invasion there was a notable downward trend on the index price, and especially on the day of the attack and the days following there were substantial decreases in returns.

The Russia-Ukraine conflict has had extensive consequences regarding, for example, humanitarian crisis in Ukraine, sanctions on Russia (Statista 2023) and comprehensive global economic impact (Liadze, Macchiarelli, Mortimer-Lee & Sanchez Juanino, 2023). Consequently, the negative impacts of the conflict were likely to reach western economies in addition to the Russian economy (Ahmed, Hasan & Kamal, 2022). As the Russian invasion of Ukraine has shocked the whole world and the war continues to unfold, information about the implications of the war is much needed.

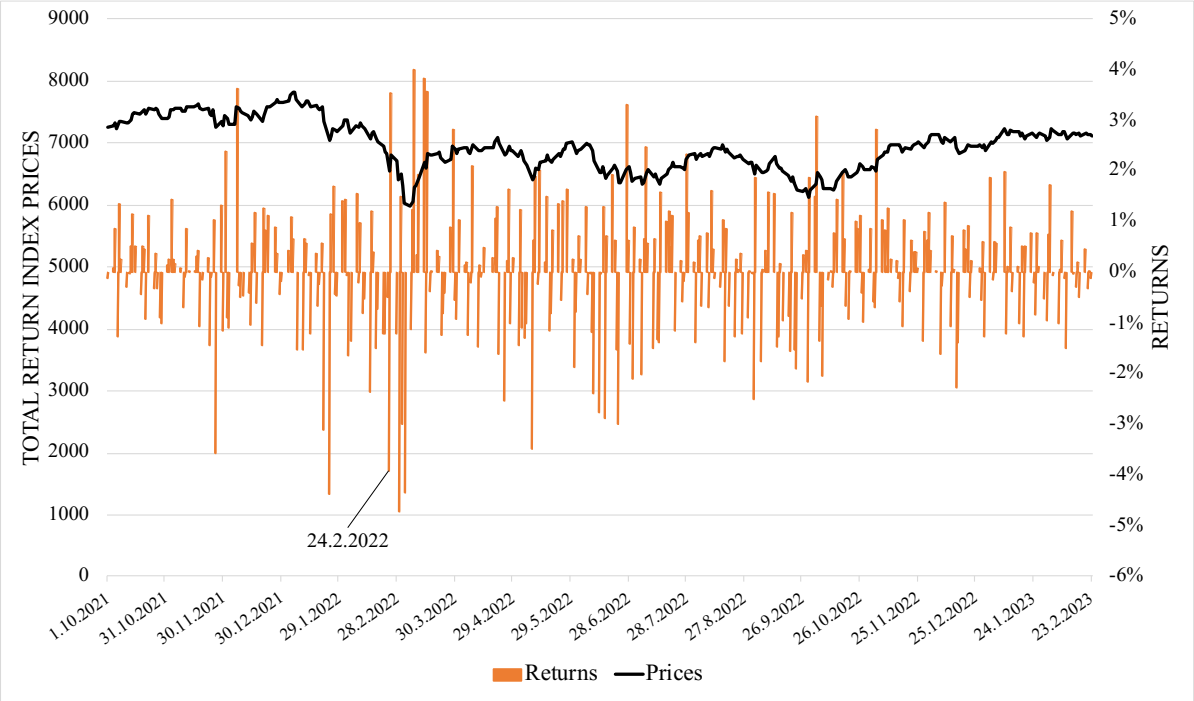


Figure 1. Price and return of OMXH25 index (Based on LSEG Workspace data 2024).

Geographical proximity to Russia or Ukraine, and the significance of economic relations with Russia have been evidenced to have influenced the severity of how the implications of the war have been reflected in a country's economy and stock markets (e.g. Boungou & Yatié, 2022 and Liadze et al., 2023). Finland is the neighbour of Russia and shares its longest border with the country. Altogether, the importance of international trade is significant for a small country like Finland (Confederation of Finnish industries 2024). In the year 2021 Russia was the fifth most significant export country for Finland with 5,4% share of the country's total exports (Statistics Finland 2023). Moreover, in the same year Russia was the second most significant import country for Finland with a share of 11,8% of total imports (Technology Industries of Finland 2022). Evidently the countries have developed a strong trade relationship, and the conflict was probable to affect the Finnish economy and the state of political uncertainty.

1.1 Background and motivation

Technology industry has a strong influence on the Finnish overall economy. The industry is the largest export sector for Finland and comprises more than half of the country's total exports (Technology Industries of Finland 2024). As exports are known to have a positive influence on the economic growth of a country (e.g. Ram, 1985 and Vohra, 2001), therefore the role of technology industry in the economic performance of Finland is significant. Besides, the industry has a strong influence on the Finnish employment rate and provides considerable tax income. (Technology Industries of Finland 2024)

Technology industry consists of five main business lines: *electronics and electrical industry, machine and metal industry, manufacture of basic metals, design and consultation, and information technology* (Technology Industries of Finland 2024). Since the industry comprises a range of business lines, the combined market value of the companies included is also significant. Figure 2 visualizes the market capitalization of the Finnish companies operating within the business lines of technology industry and their share of the total market value of the Nasdaq OMX Helsinki stock exchange between the years 2021 to 2023. As the figure shows, the companies comprise a significant percentage of the total market value of the stock exchange in question. During the period the average share of the total market capitalization was 45,70%. After the beginning of the war, a slight decrease in the share of the total market value occurred as the average reduced from 47,2% (2021) to 45,8% (2022). Nevertheless, the technology industry forms a considerable part of the total market capitalization and thus, the joint market value of the companies operating in the industry is significant in the Finnish market.

Many of the companies within technology sector have invested in Russia through exports. In 2021 the share of technology industry exports of goods to Russia increased with 24,3% compared to previous year. The share of exports of goods to Russia was 5,7% (2021) from total exports of goods of the industry. (Technology Industries of Finland 2022)

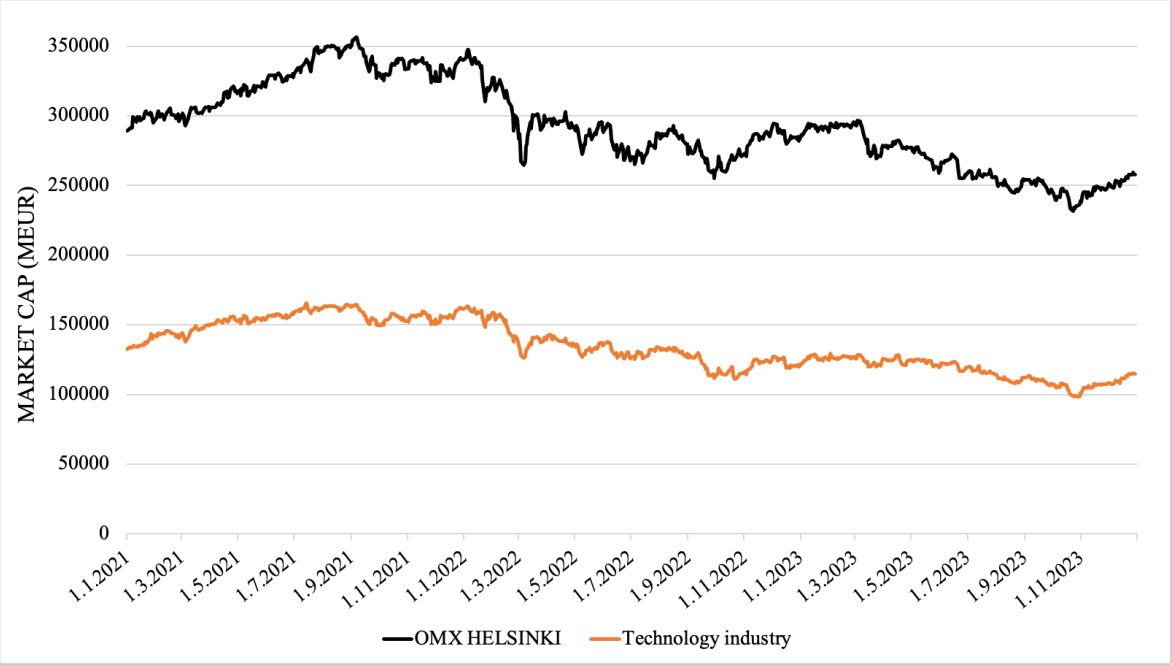


Figure 2. Market capitalization of the companies operating in the Finnish technology industry (Based on LSEG Workspace data 2025).

Relating the Russia-Ukraine war previous studies have shown that the outbreak of the conflict had a negative effect on stock markets around the world but especially Europe was among the regions to be the most adversely affected (Boubaker, Nguyen, Trinh & Vu, 2023 and Yousaf, Patel & Yarovaya, 2022). Additionally, Boungou and Yatié (2022) found that specifically those countries which share border with Russia or Ukraine were most affected by the invasion. Liadze et al. (2023) suggested Europe has been most affected by the war due to its important trade relationship with Russia. Then Lo, Marcelin, Bassène and Sène (2022) evidenced that higher dependence on Russian commodities led to the greater negative effect. Thus, considering the strong trade linkage between Finland and Russia and the significant investment of the technology industry to Russia through exports, the concern of the impact of the Russia-Ukraine war on the Finnish technology industry companies is justified. Also, as a Finnish citizen the writer is concerned by the Russia-Ukraine war due to the adjacent geographical proximity and the spillover effects of the war on the overall Finnish economy.

This study focuses to examine the impact of the Russia-Ukraine conflict on the stock performance of Finnish technology industry companies. The topic of the research is

important considering the important trade relationship between Finland and Russia, the considerable investment of the Finnish technology industry to Russia and the significant influence of the technology industry for the overall Finnish economy. Also, the topic is relevantly current considering the timing of the events as the war has continued to this date. This study differs from other studies of market reactions to the Russia-Ukraine war as multiple events over the first year of the war are included into the research. Additionally, the study focuses on the Finnish technology industry which other studies regarding the conflict have not yet focused on. The war events being studied are divided to two categories, military events and non-military events, which also offers a new perspective on the subject as previous research have focused mainly on the day of the first attack. With this, the research aims to analyze whether these war-related events have influenced the performance of the stocks in question and whether there has been any difference in the impact between the event types. Additionally, the research carries out a brief analysis of the long-term effects of the war on the stock price performance.

1.2 Research questions and hypotheses

The aim of this study is to examine the impact of the Russia-Ukraine conflict on the stock price performance of Finnish technology industry companies during the first year of the war using the event study methodology. According to the efficient market hypothesis (EMH) all relevant information considering assets is directly reflected on their market prices (Fama, 1970). Given that the markets are rational, asset prices should reflect the influence of an event without a delay (Campbell, Lo & MacKinlay, 1997, 149).

As the risk of war and military conflicts has been found to influence stock markets causing price movements of stocks (e.g., Choudhry, 2009; Hudson & Urquhart, 2015 and Rigobon & Sack, 2005) the information of the Russia-Ukraine conflict should have influenced the stock prices. Previous studies have focused to examine only the event day when Russia invaded Ukraine (e.g., Boubaker et al., 2023 & Ahmed et al., 2022). To understand the impact of the war on the Finnish stock market more comprehensively, multiple events from the first year of the war were selected to this research. Furthermore, both military and non-military events have been found to cause stock price movements, but the investors' interpretation of the event's implications is commonly reflected in the direction of the change

(Choudhry, 2009). Hence, events from both categories were selected under research. The objective is to study the overall movements of the stock prices and then for any significant changes it is determined whether the Finnish stock market perceived the event to have influenced positively or negatively.

Thus, this study addresses the following research questions:

> *RQ_1: How did the events of the Russia-Ukraine conflict impact the abnormal stock performance of Finnish technology industry companies?*
>
> *RQ_2: Have there been differences between military and non-military events in the impact on Finnish technology industry companies' stock returns?*

Commonly the null hypothesis (H_0) of an event study is that the event does not have an effect on stock returns. If the null hypothesis is rejected, it can be concluded that the event had an influence on the returns. (MacKinlay, 1997)

Therefore, the hypotheses of the research were set accordingly:

> *H_1: The events of the Russia-Ukraine war did not have an impact on the performance of the Finnish technology industry companies.*
>
> *H_2: There is no statistically significant difference between the impacts of military and non-military events on the stock returns of the Finnish technology industry companies.*

Even though previous research have evidenced that the Russian invasion of Ukraine did adversely affect the stock markets, setting these hypotheses is more distinct because the research includes several war related events during the first year of the war for which no previous research results were found.

This study aims to answer the research questions by examining the total return index prices of the selected Finnish technology industry companies' stocks and the OMXH25 index. The

research includes data from 29th of September 2021 to 23rd of February 2023. The research is carried out by using the event study methodology. The purpose of the methodology is to examine how financial markets react to new information and consequently, the impact of an event on stock returns. The event study methodology aims to measure abnormal changes in stock prices after an event and analyze whether the market reaction to new information was positive or negative. The methodology assumes that to some extent future stock returns are predictable as the past stock prices are used to predict future returns and then compared to the actual returns that occurred. The aim is to find differences that exceeds the normal level of variation. (MacKinlay, 1997 and Wells, 2004)

Additionally, since the war still continues to unfold to this day, the study also examines how the stocks have performed afterwards. This is studied by calculating the cumulative returns for every company in the research and for the index. Period of one year after the latest event is used to calculate the cumulative returns and in total, these are calculated for four different periods: 1 month, 3 months, 6 months and 1 year.

1.3 Key results

Similar to Choudhry (2009) the study found that the Finnish technology industry companies' stock price performance was influenced by both event types, military and non-military. Even though the investors did not react to all the events under research, the results indicated that most of the events related to the Russia-Ukraine war did impact the abnormal stock performance of the Finnish technology industry companies. Moreover, independent from the type of the event, both positive and negative reactions were observed. Instead, analogous to Choudhry (2009), generally the markets' interpretation of the event's consequences was reflected in the direction of the stock price movement. Typically, investors considered the Ukrainian victories or support provided for Ukraine as positive news and contrarily Russian threats or attacks as negative news. However, the results also indicated that an increase in political risk or the dispersed publication of news may have had an influence on the reactions to some of the events.

Furthermore, to increment the previous literature on the topic, the results showed that, unlike generally in Europe, the technology industry stocks in Finland were immediately influenced by the outbreak of the war possibly due to the importance of the technology industry to the

Finnish economy. However, since the market reaction to the initial invasion was positive, the publication of news over several days may have caused the markets to expect the event to occur. Regarding the different event types, the results indicated that on average the military events more often lead to a positive reaction whereas for non-military events the effect was negative on average. However, the differences between the event types in terms of their influence on returns were not significant. Overall, the results showed that other events of the war, than only the initial invasion, have also influenced the abnormal stock performance of the Finnish technology industry companies.

The long-term performance analysis suggested some companies managed to recover from the implications of the war faster while others struggled with the challenges perhaps provided by the restrictions on trade with Russia. From the main business lines of the technology industry, the adverse effects of the war on long-term performance concerned most the information technology sector whereas the machine and metal industry sector was most successful to recover. The analysis indicated that the effect of political risk on the overall market contributed to the unfavorable stock price performance of majority of the companies but also the ability to recover was influenced by the companies' own efforts. Altogether the results suggest the events of the Russia-Ukraine war have influenced the perception of political risk in Finland and the uncertainty has been reflected in the behavior of the Finnish technology industry companies' investors.

1.4 Limitations

For the most part, the limitations of the study are related to selection of the events and therefore the determination of the event dates. Since the event study methodology examines the impact of an event on stock prices, determining the correct event date is essential. The issue of overlapping events provides a great challenge for event studies which involves high-frequency events. (Wells, 2004) There have been numerous events in the war between Russia and Ukraine, and especially in the early days of the war there were many, which could have influenced the results. Excluding the overlapping issue is difficult and avoidable merely by a more complex model.

Additionally, there has been a lot of media coverage of the war from different news sources and at different times. For this reason, the study could not completely exclude the possibility

that news published around the event dates would have reached investors at different times thus affecting the stock prices and ultimately the results. Also, the possible influence of other events, not related to the war, could not be completely excluded.

1.5 Structure of the thesis

The structure of the study consists of six sections. The introduction is followed by the theoretical framework of the research. At first, the chapter introduces theory of how political risk affects the economy. Second, the theory of comparative advantage is presented and followed by a discussion of how Finland has tried to gain relative advantage by specializing in technology. Then, the chapter encompasses the theory of efficient markets which is relevant for the event study methodology applied in this study. After this, the influence of information asymmetry on asset prices is discussed. Lastly, the chapter introduces how behavioural aspects influence stock prices.

The third section of the study covers the literature review. Firstly, technology industry in Finland is considered and the industry's importance for the country is addressed through related literature. Secondly, the impact of political risk on financial markets is covered. Then, sanctions' influence on international trade and stock markets is reviewed. After this, literature on how previous wars have affected financial markets is discussed. Lastly, the review considers previous literature on the Russia-Ukraine war.

The fourth section of the study consists of presentation of the data and an introduction of the methodology implemented. Then, the fifth section covers the results of the research and provides a discussion of them. Lastly, the study derives conclusions. In the sixth chapter the research questions are answered, and the reliability of the research is analysed. Also, thoughts of further research ideas are shared.

2 Theoretical framework

This chapter encompasses the theoretical framework of this research. First, the section covers the influence of political risk on the economy. Second, the theory of comparative advantage and the Finnish specialization in technology industry is discussed. Then, the review considers the efficiency of stock markets. After this, the chapter presents theory related to information asymmetry and how it influences stock prices. Finally, the behavioral factors of investors and their influence on stock prices is discussed.

2.1 Political risk and the economy

The increase in political risk presumably influences a country's economy and government decision making may be more short-sighted when political environment is uncertain (Aisen & Veiga, 2013). Considering the significant trade relationship with Russia for the Finnish economy and the adjacent geographical location, the Russia-Ukraine war could possibly be reflected in the perception of the state of political risk in Finland ultimately influencing the Finnish economic situation. Hence, the relation between the political risk and the economy will be discussed next.

It has been evidenced that political risk has an impact on the economic performance of a country and the influence is reflected in the economy through different macroeconomic variables (e.g. Aisen & Veiga, 2013, Darby, Li & Muscatelli, 2004, Devereux & Wen, 1998 and Le & Zak, 2006). For instance, political instability has been found to have a negative effect on economic growth (e.g. Darby et al., 2004 and Jong-A-Pin, 2009) as countries with higher levels of political instability often experience significant decrease in the growth rates of GDP per capita. This adversely affects productivity growth rates and hence slows down the economic growth. (Aisen & Veiga, 2013) Policy uncertainty also slows down economic growth by decreasing the GDP growth level (Diakonova, Ghirelli, Molina & Pérez, 2023). Hence, higher political risk can yield economic slowdown.

The efficiency of public investment essentially contributes to economic growth (Tovar Jalles, Park & Qureshi, 2024). Allocating government funds to public investment tend to elevate productivity and therefore enhance growth (Morrison & Schwartz, 1996). With

greater political uncertainty, governments tend to reduce public investments and shift budgets to current consumption instead of capital spending (Darby et al., 2004). Therefore, economic growth can also be diminished by the impact of political risk on public investment.

Furthermore, political risk induces capital flight and reduces growth as capital flight has a significant impact on GDP (Le & Zak, 2006). Political instability induces inefficient allocation of resources and can result in higher share of government spending in GDP. Consequently, when governments consume the economy's assets, the probability that capital taxation will be increased in the future is higher which in turn depresses private investment. (Devereux & Wen, 1998) With this, higher levels of political instability have been found to increase the uncertainty of future and thereby reduce private investment due to higher risk (Alesina & Perotti, 1996). Therefore, economic growth is diminished by the influence of political risk on the efficiency of private investment (De Gregorio & Guidotti, 1995). Additionally, political risk reduces capital accumulation due to its influence on foreign direct investment (FDI) since higher political risk adversely affects FDI by increasing the risk of return (Hayakawa, Kimura & Lee, 2013).

Political risk also influences inflation rates. Higher political uncertainty increases inflation and leads to a reduction in consumer spending (Jawadi & Pondie, 2024). Also, higher political instability has been found to generate higher inflation as policy myopia complicates to maintain lower inflation. Such governments may also rely more on seigniorage revenues instead of developing efficient tax systems. (Aisen & Veiga, 2006) Furthermore, political instability increases the volatility of inflation rates (Aisen & Veiga, 2008). High inflation rates can have a negative effect on growth whereas for lower inflation rates the impact is positive (Crespo Cuaresma & Silgoner, 2014). Hence, higher political risk can lead to a decrease in economic growth through accelerating inflation rates and decreasing consumer spending.

Additionally, political risk is reflected in the economy through its effect on employment. Higher political uncertainty influences the hiring behavior of firms and may cause them to cease hiring temporarily. (Bloom, 2009) Specifically, higher geopolitical risk has been observed to increase unemployment due to the increased probability of disaster (Caldara & Iacoviello, 2022). As uncertainty increments unemployment, it can affect consumer investment and consumption decisions further influencing growth (Al-Thaqeb, Algharabali, Alabdulghafour, 2022).

Overall, political risk influences a country's economy on multiple ways. Due to the essential trade relationship between Finland and Russia and the countries' adjacent geographical location, the Russia-Ukraine war may have spillover effects to the state of political certainty in Finland. Higher political risk may decrease the economic growth of a country, reduce the capital accumulation, increase unemployment and lead to higher inflation diminishing consumer spending. Hence, the increase in political risk resulting from the consequences of the Russia-Ukraine war may ultimately be reflected in Finland's economic development.

2.2 Comparative advantage and specialization

Companies and countries which are more competitive in production costs are more likely to succeed in the international markets (Bank of Finland 2022). Besides, in the theory of comparative advantage, production costs and specialization are central to more productive international trade (Eaton & Kortum, 2012). The Russia-Ukraine war has provided a challenge for companies to manage expenses due to the restrictions on trade with Russia (Bank of Finland 2022). This has concerned the companies within the technology industry as the sanctions have been targeted, among others, on trade in technology (Customs 2022).

2.2.1 The theory of comparative advantage

The theory of absolute advantage was originally presented by Adam Smith in 1776 to provide rationale for free trade (Eaton & Kortum, 2012). Absolute advantage theory was based on the idea that the costs of producing diverse commodities are distinct between different countries due to the differences in natural advantages and acquired advantages, e.g., climate and education, respectively. According to the theory, countries should specialize on the production of those commodities in which they are more efficient. With the efficient allocation of resources more commodities could be produced, over the particular demand, and therefore the surplus could be traded between countries. However, the absolute advantage theory failed to consider the comparative costs. (Myint, 1977)

The theory of comparative advantage, introduced by David Ricardo in 1817, sought to provide an enhanced justification for international trade. A situation where a country is superior in the production of multiple commodities was not considered by the absolute

advantage theory. Comparative advantage theory suggests that countries should specialize in the production of that commodity in which they are comparatively more efficient or in other words, have relatively lower production costs. Consequently, they would produce relatively more and thus obtain greater productivity. The excess production could be exported and therefore specialization would benefit both parties of a trade. (Eaton & Kortum, 2012)

2.2.2 Finnish specialization in technology

For a small country like Finland international trade is essential. However, success in the export markets requires competitive merchandise. (Confederation of Finnish industries 2024) In order to enhance its competitivity Finland has allocated a considerable investment to the development of the technology industry. The annual investments of the industry to Finland are approximately 6 billion euros and the majority (65%) of all research and development investments in the Finnish business life is made by the companies within the sector. In addition, the country has invested in human capital within the sector by providing considerable employment. Nowadays the employment impact of the industry is approximately 338,000 people. (Technology Industries of Finland 2024) Thus, Finland has attempted to gain comparative advantage through specializing in technology and investing in the acquired advantages of the country.

The specialization in the technology industry has provably had a positive impact on the Finnish economy. The industry brings considerable income through exports and its contribution is used to maintain the well-being of society. Nowadays the technology industry has a strong position in the Finnish economy. However, the sector is highly dependent on the world situation as majority (80-90%) of the production of the industry end up exported (Technology Industries of Finland 2024). The global events of the recent years have affected the entire industrial sector and exporting. First, the COVID-19 pandemic and the subsequent restrictions reduced exports in 2020. (Confederation of Finnish industries 2024) The economic implications of the pandemic began to ease in the following year, after which the world economic upswing began to weaken again due to the Russian invasion of Ukraine in early 2022 (Industrial Union 2022). The economic isolating of Russia that followed the war led to a decline in industrial production in Finland (Industrial Union 2023) and diminished

exports (-68%) to Russia substantially (Confederation of Finnish industries 2024). Before the war in 2021, there was an upward trend in the Finnish technology industry exports to Russia (Technology Industries of Finland 2022) but after the invasion, as the imposed sanctions particularly concerned the technology industry, the industry's exports to Russia were mostly prevented (Customs 2022). Thus, in 2022 and 2023, Russia has not been even among the 20 most significant exporting countries of the Finnish technology sector (Technology Industries of Finland 2024). Evidently the Russia-Ukraine war has affected the Finnish technology industry.

As stated, in the theory of comparative advantage, relatively lower production costs and higher productivity are fundamental (Eaton & Kortum, 2012). With the restrictions on exports, the companies in the industry have been forced to look for new markets for their products. In order for Finland to have economic success in the future, maintaining its cost competitiveness is essential. (Bank of Finland 2022) Thus, adaptation of the companies to the changes in the economic environment is key to have comparative advantage in technology in the future.

In addition to the uncertainty related to the world geopolitical situation, the difficult economic cycle of the technology industry in the past years has been challenged by the accelerating inflation rates and the uncertainty of interest rate development. The increased interest rates weakened the overall demand and with that many previously profitable investments became unprofitable. Thus, companies ended up postponing investments. (Technology Industries of Finland 2023). Even though to this date inflation has leveled off and interest rates have decreased, the weak industrial cycle has not been overcome yet (Technology Industries of Finland 2024).

2.3 The efficiency of markets

The event study methodology has been often applied to test the efficiency of markets (Binder, 1998). Market efficiency refers to the level of how well all available and relevant information is reflected on asset prices (Fama, 1970). As event studies pursue to measure the impact of an event on stock prices, the efficiency of markets is assumed (Wells, 2004).

According to the efficient market hypothesis (EMH) all relevant information considering assets is reflected on their market prices without delay. (Fama, 1970) If markets are efficient, they adapt so quickly to new information that a randomly selected portfolio would yield equivalent profits as could be obtained with different analysis methods, given the comparable risk level. In an efficient market an investor should take on more risk to gain above market returns as the efficiency eliminates opportunities to outperform the market. (Malkiel, 2003)

2.3.1 Formation of the efficient market hypothesis

The early assumption of the EMH that markets fully reflect all available information implied to subsequent security price changes being independent. Thus, initially the theory of efficient markets was based on the idea of random walk. (Fama, 1970) Random walk considers the price changes of securities only reflect information of the current moment and are independent from the past. The unpredictable nature of news would lead to the price movements of securities being random. Therefore, future stock prices could not be predicted based on historical price information as the prices change only as a consequence of new information. (Malkiel, 2003)

To address the critique whether the security prices fully reflect all available information, the theory of efficient markets was enhanced. In 1970, Fama defined three forms of efficiency by the degree of the capability the stock markets process information: weak form efficiency, semi-strong form efficiency, and strong form efficiency. The markets are weak-form efficient when historical stock prices can't be used for prediction of future returns as the information is already reflected in current prices. (Fama, 1970) Then, analysis of asset fundamentals could provide the investor an opportunity to outperform the market (O'Sullivan, 2018). In semi-strong efficient markets, all the publicly available information is also incorporated to stock prices in addition to the information of historical prices (Fama, 1970). If markets are semi-strong efficient, an investor could outperform the market by obtaining relevant information which is not publicly available (O'Sullivan, 2018). Markets are strong form efficient if all possible information, including information of the inner circle, is reflected in stock prices (Fama, 1970). This would mean that the market could be

outperformed merely by good luck (O'Sullivan, 2018). At the time, the theory was widely accepted, and markets were believed to be strongly efficient (Malkiel, 2003).

2.3.1 Market efficiency and CAPM relationship

In order to test the efficiency of markets, specification of the process of price formation is required. The theory assumes market equilibrium is expressible in terms of expected returns and therefore such model should be used to test the hypothesis. (Fama, 1970) The Capital Asset Pricing Model (CAPM) employs the trade-off between expected returns and risk and provides predictions of how risk can be measured (Fama & French, 2004). According to the theory, optimally investors hold a portfolio with highest expected return for a given risk level, i.e. a mean-variance efficient portfolio (Campbell et al., 1997, 181). Even though the CAPM as such is not used in the market model of event study methodology (Wells, 2004), it is linked to market efficiency as EMH presupposes CAPM to some extent, particularly in the prediction that markets will be efficient (O'Sullivan, 2018). Furthermore, it is common practise to test market efficiency by implementing an event study (Binder, 1998) and since the market model utilizes beta, which is in essence in the CAPM, in calculating expected returns (Wells, 2004) the theories are related.

The CAPM considers the total risk of a portfolio consists of unsystematic risk and systematic risk. The unsystematic risk describes a part of the total risk, which is associated with a specific investment, for example on an industry- or corporate-level. (Knüpfer & Puttonen, 2018, 148) The CAPM assumes that risk-averse investors diversify their portfolios until only the systematic risk remains. In financial literature, systematic risk describes the market risk of an asset. It reflects the investment's responsiveness to the changes in overall economy. Contrary to other types of risks, systematic risk cannot be avoided by diversification. The market risk of an asset is often described with beta (β). (Sharpe, 1964)

Beta is a risk indicator that describes the systematic risk of a stock. The measure is widely used in asset pricing. Moreover, beta is also used when estimating the expected returns with the market model in the event study methodology. The threshold for an average risk stock is considered to be 1.00. Such stock would be strongly correlated with the market. Values above the threshold are an indication of a higher risk and thus, the price movement of a stock is expected to be more volatile compared to the average market. In favorable market

conditions high beta stocks tend to have expected returns higher than average and lower than average in adverse conditions. Values below the 1.00 threshold indicate lower risk and such stocks are usually less volatile than the average market. (Wells, 2004)

According to Fama (1968) the beta of an investment can be calculated followingly:

$$\beta_i = \frac{Cov(R_i,R_m)}{\sigma_{m^2}} \quad (1)$$

In which β_i is the beta of the investment, R_i is the return on individual asset, R_m is the market return, $Cov(R_i,R_m)$ is the covariance of returns and σ_m^2 is the variance of the market portfolio. Fama's (1968) formula for beta calculation is common in financial literature (Vergara-Fernández, Heilmann & Szymanowska, 2023).

Despite the importance of the Capital Asset Pricing Model in modern asset pricing (Vergara-Fernández et al., 2023) the theory has been challenged through various research, for example through anomalies, and consequently faced criticism (Frankfurter & McGoun, 2001). There is contradictive evidence on the assumption that only the market risk would be valued by investors as all other risk could be avoided through diversification. For instance, James and Edmister (1983) found supporting evidence on the firm size anomaly when they studied the returns of common stocks between years 1975 to 1979. Their findings suggested risk-adjusted returns were affected by the company size. Whereas Irvine, Kim, and Ren (2024) found supporting evidence on the beta anomaly. The study focused on the U.S. equity mutual funds between the years 1993 to 2019. The beta anomaly suggests a tendency for assets with high betas to yield returns lower than predicted by the CAPM and in contrary, for assets with low betas to yield higher returns than expected.

The criticism towards the CAPM considers also the theoretical assumptions and the challenges of the empirical testability. For example, the assumption of the availability of risk-free assets for all investors has been criticized. (O'Sullivan, 2018) This issue was addressed by Black in 1972 with a derived model of the CAPM which does not account for the risk-free rate but replaces it with a possibility to unlimitedly short sell risky assets. Black (1993) also underlined the importance of beta in investment decision making despite the possibility of the beta anomaly as even low-beta investments appear interesting due to

positive alphas. Despite the criticism of CAPM's shortcomings the theory has been used as a basis for building more extensive models and is still widely used to assess portfolio performance and cost of capital (Fama & French, 2004).

2.3.2 Criticism considering market efficiency

Later, the theory of efficient markets has also been often challenged. Studies focusing on market irregularities which are not predictable, such as anomalies, have provided contradictive evidence to the theory. (Frankfurter & McGoun, 2001) Evidence of seasonal and day of the week patterns in stock returns have been found. Easterday, Sen and Stephan (2009) showed evidence of the January effect which suggests the returns are higher in the said month. The study examined common stocks listed in AMEX, NASDAQ, and NYSE between the years 1946 to 2007. Cross (1973) found evidence of the weekend-effect as he studied the S&P Composite Stock Index during the years 1953 to 1970. The results showed a tendency for the asset prices to increase on Fridays and decrease on Mondays contradicting market efficiency. Also, the research of Caporale, Gil-Alana and Plastun (2016) found supporting evidence of the weekend anomaly. They studied the Ukrainian stock market between 2010 to 2014. The results suggested inefficiency in the market as the results indicated abnormal positive returns on Fridays.

Also, the behavioural factors have been argued to affect investors' decision making, thus influencing stock prices (Shiller, 2003). De Bondt and Thaler (1985) showed evidence of weak form market inefficiency. They studied the overreaction hypothesis by using the NYSE data during the time period 1926-1982. The study found evidence the overreaction of investors to unexpected events leads to price movements of stocks hence challenging the theory of efficient markets. The results showed that previously weak portfolios ("losers") outperformed the previously superior portfolios ("winners").

However, such market discrepancies are unlikely to persist enabling investors to gain abnormal profits for long periods of time. Although anomalies have been found to appear in the markets, it does not lead to investors being able to make profits higher than average without accepting a higher risk level (Malkiel, 2003). Regardless of the criticism towards the theory, market efficiency is an important assumption for the event study methodology (Yen & Lee, 2008). One of the assumptions of the event study methodology is that the

financial markets' reaction to new information should be reflected in stock prices. Thus, the markets are assumed to be efficient. (Wells, 2004) Additionally, event studies have provided supporting evidence on market efficiency as on average asset prices quickly react to new firm-level information (Fama, 1991).

2.4 Information asymmetry and political uncertainty

In the world of today new information is provided through various media channels and news generally spread quickly. Consequently, the reportage of the Russia-Ukraine war as well has been extensive and diverse. Often the publication of information might be dispersed and hence the new information might reach investors at different times. This is problematic for event studies in which the implication of new information to stock prices is assessed (Wells, 2004). Information asymmetry describes the situation where market participants hold different amount of information. Unlike the standard asset pricing models, research focusing on information asymmetry have proposed the differences in possessed information influence asset returns as investors make decisions based on their knowledge at the time. (Aslan, Easley, Hvidkjaer & O'Hara, 2011)

Investors may have a different perception of the risk of a stock if the level of information is differing. The influence of information asymmetry on asset pricing is often described as information risk. (Aslan et al., 2011) Easley, Hvidkjaer and O'Hara (2002) studied whether information risk affects asset returns. They generated a measure which estimates the probability of information-based trading in individual stocks and evaluated it using stocks of the New York Stock Exchange during the years 1983 to 1998. The results showed higher expected returns for stocks with higher probability of information-based trading. Hence, their research provided evidence for the presumption that asset prices are affected by information indicating investors price the information risk. The research of Goel, Tripathi and Agarwal (2021) also provided evidence of investors demanding a higher return to hold stocks with greater information risk. Their study focused on the Indian stock exchange, NSE, between the years 2000 to 2018. The results also showed stocks with greater information risk outperformed stocks with less information risk indicating that investors were actually compensated for bearing the higher risk level. Easley and O'Hara (2004) suggested the

higher required return is caused by the advantage of informed investors to allocate their funds reflecting new information, compared to uninformed investors.

Yuan (2005) studied information asymmetry and proposed a model of crises and contagion in a market where also borrowing constraints appear. The research argued that as borrowing constraints influence the ability of the informed investors to transmit information, uninformed investors may choose to sell stocks as they are uncertain in interpreting the information of falling prices eventually exacerbating the price decline. Therefore, higher information asymmetry can amplify the stock price decline and lead to an asset crisis. Flugum, Orlova, Prevost and Sun (2021) suggested that higher information asymmetry increases the probability that investors will overreact to bad news. If information is withheld, the ability of investors to process information weakens as bad news are released sequentially. This may lead to a crash in the stock price due to the overreaction of investors to the released information. Aslan et al. (2011) argued that in addition to the frequency of news events the magnitude of information risk on stock prices is dependent on the number of investors holding better information. According to Easley and O'Hara (2004) as well, asset prices are influenced by both the quantity and the quality of information.

Previous research has showed evidence of information asymmetry affecting stock returns as investors hold different information. This increases the risk of mispricing of assets as investors forecast differing returns and thereby end up holding distinct portfolios. The degree of the information asymmetry and the frequency of news events influences the magnitude of the impact on returns. At its worst, higher information asymmetry can possibly exacerbate the stock price decline and lead to a crash.

2.5 Behavioral explanation of political risk

As discussed, the aim of an event study is to measure the reaction of financial markets, i.e. investors, to an event and how it is reflected in stock returns (Wells, 2004). The traditional financial theories often assume investors are rational in their decision making. For instance, the EMH proposes that in efficient markets the prices fully reflect all available information and hence the prices change only as new information arises. Thus, it assumes markets are rational (Fama, 1970). The behavioral approach challenges the traditional field and its assumptions on investor behavior. Behavioral finance is a sub-discipline of behavioral

economics which has grown in popularity over the past decades. (Thaler, 2016) In essence, behavioral finance examines the relationship between human behavior and financial markets (Shiller, 2003). The contributions of Kahneman and Tversky (1979) and of Thaler (1980) are considered significant in terms of the development of the field. (Thaler, 2016). The approach challenges investor rationality and argues the psychological factors influence investor decision making. Such studies have found evidence that contradict theories which are based on rational decision making of investors, suggesting that the investor behavior would contribute to influence asset prices. (Thaler, 2016)

The prospect theory, i.e. loss aversion, depicts investor decision-making under risk. The theory was developed by Kahneman and Tversky in 1979 and 1992 to address the shortcomings of the expected utility theory, which assumed investors pursue to maximize their utility in decision-making. (Kahneman & Tversky, 1992) Loss aversion suggests gains and losses are valued differently by investors as the tendency to fear losses is greater than the tendency to value gains (Kahneman & Tversky, 1979). Later, several research have found evidence to support the theory. The research of Merkle (2020) focused on loss aversion by studying investors of a large UK bank. The results showed the investors were to react twice as much to negative expected returns compared to positive expected returns. Akin and Akin (2024) studied the US stock market and the impacts of behavioral factors to its volatility. This was analyzed by examining the performance of the S&P500 index through a 10-year time period and by including different financial indicators, e.g. the real interest rates and the volatility index, as dependent variables. The results showed a negative relationship between the S&P500 and the real interest rates indicating a decrease in the index when there is an increase in the real interest rates. Similar negative relationship was observed between the S&P500 and the volatility index. They suggested the fear of losses, i.e. loss aversion, would contribute to influence the investor decision making, leading investors to sell stocks and potentially replace them with less risky assets. Similarly, the fear could affect investor behaviour in high volatility conditions leading to a decrease in the index. (Akin & Akin, 2024) Vasileiou (2021) studied the behavior of financial markets by examining market efficiency of the U.S stock market, specifically the S&P500 index, during the COVID-19. The research showed evidence of market inefficiency and indicated the market reaction could not be explained by economic variables only. The research suggested as well that fear as a behavioral factor could be better utilized to explain investor decision making during uncertain times.

As discussed, De Bondt and Thaler (1985) studied the overreaction hypothesis and its effect on stock prices. They found supporting evidence of a tendency for investors to overreact to unexpected events. The overreactive behaviour of investors affected the formation of stock prices. Later De Bondt and Thaler (1987) amplified the previous research results and provided supplementary evidence on the overreaction hypothesis. The subsequent study extended the objective to address the explanatory factors of the overreaction hypothesis, as well as the seasonality effect and the firm-size effect. They concluded that the winner-loser effect cannot be derived from changes in risk nor from the size effect. However, again the results provided support for the overreaction hypothesis. Additionally, Akin and Akin (2024) presented the herding behaviour of investors as an alternative interpretation to explain the negative correlations. Herding behaviour is known to illustrate the tendency of investors to make decisions based on crowd behaviour. This has been observed to occur particularly during uncertain times. For example, a decrease in stock prices can be caused by considerable number of investors exiting the market due to a heightened volatility. (Akin & Akin, 2024)

The common factor for the research results is the idea of behavioural finance: the behavioural factors are to influence investor decision making and ultimately affecting the price formation of stocks. As wars cause uncertainty in the society, hence behavioural factors, such as fear, can influence investor decision making. Consequently, also the rise in political uncertainty in Finland following the war between Russia and Ukraine may also be reflected in investors' actions which would ultimately contribute to the formation of stock prices.

3 Literature review

This section provides a review of previous literature on how international crises and wars influence the financial markets. First, the significance of the technology industry on the Finnish economy is discussed. Then, the review considers the influence of political risk on stock markets. Next, the effectiveness of sanctions as political means to promote policy change is considered. Then, event studies focusing on previous wars and how the market's interpretation of different types of events is known to affect the outcome are discussed. Lastly, previous research focusing on the Russian invasion on Ukraine and it’s influence on the financial markets are presented.

3.1 Technology industry in Finland

Technology industry is the largest line of business in Finland. The industry develops sustainable solutions to the problems of the society and the environment. Furthermore, especially in the case of Finland, the industry produces significant economic benefits for the country. (Technology Industries of Finland 2024)

Technology industry became, along with the success of Nokia, the main sector for the Finnish economy in the 1990s (Kaitila, 2019). Despite the recession, the industry experienced a quick growth as the number of high technology firms increased remarkably (Autio & Yli-Renko, 1998). Specializing in technology offered Finland competitiveness and an opportunity to succeed internationally. Shortly, the country achieved a leading position in the production of information and communication technologies, even internationally. The position of the Finnish technology industry throughout the years has been enabled by various facor, such as government policies, support for innovation, education, and research and development activities. (Kaitila, 2019 and Oinas, 2005)

Finland is a small country and thus, the importance of international trade on the economy is considerable. For a country to succeed internationally, competitiveness is in essence. (Confederation of Finnish industries 2024) Autio and Yli-Renko (1998) analysed the impacts of new technology based firms in Finland during 1986 to 1993. According to the analysis, the smaller technology based firms have had a significant impact on the efficiency of larger

operators and on the development of technology in general. By increasing efficiency, smaller firms have contributed to improving the international competitiveness of the industry. Furthermore, in addition to large corporations, small new technology based firms have had a significant employment effect in Finland. According to the analysis, the employment impact of a single new technology based company may be relatively small but nevertheless stable. However, the large number of new technology based firms contribute to the number of positions and has also led, in many cases, larger companies to outsource within Finland instead of abroad, and thereby again increasing employment in Finland. (Autio & Yli-Renko, 1998) Nowadays the employment effect of the Finnish technology industry is considerable (Technology Industries of Finland 2024).

In general, exports have been proven to have a positive influence on a country's economic growth (e.g. Ram, 1985 and Vohra, 2001). Especially for Finland, Konstantakopoulou (2017) found supporting evidence of the ELG hypothesis as the study focused on the connection of exports and economic growth in OECD countries. The results suggested that Finland would benefit from export-oriented policies to increase economic growth rates. Additionally, Kónya (2006) studied the relationship between real exports and real GDP, also in OECD countries, between the years 1960 to 1970. The results of the study showed that in the case of Finland a two-way causality between exports and economic growth exists. Hence, both studies showed that exports have an increasing influence on Finland's economic growth and thereby enhance the country's economy.

Nowadays the Finnish technology industry companies operate on international markets and therefore bring considerable income to the country through exports. The sector is important for the country's overall export industry as more than 50% of all Finnish exports are produced by the technology industry. Also, the sector contributes approximately 30% of the value added of the GDP. (Technology Industries of Finland 2024) Consequently, as exports have been found to increase Finland's economic growth and the technology industry comprises the majority of the country's total exports, the industry's importance on the Finnish economic growth is significant.

Considering the significant contribution of the technology industry to Finnish exports and the influence on employment, the significance of the industry to the country's economy is undisputable. The technology industry is a significant sector for the Finnish economy, and the industry plays an important role in building the country's successful future.

3.2 Political risk and financial markets

International crises and the risk of war perceivably cause uncertainty in the economy. The relationship between political uncertainty and the stock markets has been studied by various research. Political uncertainty has been observed to influence financial markets indicating that the markets generally do price political risk (Pástor & Veronesi, 2013 and Liu, Shu & Wei, 2017). Even a locally originated political crisis can potentially influence the financial markets worldwide (Gala, Pagliardi & Zenios, 2023).

In the research of Pástor and Veronesi (2012) they derived a model which suggested that an increase in political uncertainty adversely affects stock prices. The decline in stock prices would reflect the higher expected returns required by the investors due to the increasing uncertainty. Liu et al. (2017) focused on the political scandal in China in 2012 and examined the stocks of 1924 companies in the China Stock Market. They provided evidence for the increase in the discount rate to cause fall in stock prices implying that political risk is indeed priced by the markets. Analogously Li, Liu, Liu, Liu and Zhu (2024) implied increasing political risk adversely affects stock prices. They studied the Chinese stock market during the Taiwan missile event on 1st of July 2016. The study argued the main component to cause fall in stock prices due to political uncertainty is the increase of the required rate of return of investors. Thus, previous research have provided evidence that political risk influences stock performance and specifically an increase of the risk leads to a decrease in the prices.

In another research Pástor and Veronesi (2013) studied the reaction of financial markets to political news and how the markets price political risk. By using the policy uncertainty (PU) index and examining the daily returns of the S&P500 index and the average daily value of the Chicago Board Options Exchange's VIX index they derived another model to reflect the stock market reaction to political news. The model implied the higher rate of return required by the investors due to increasing political uncertainty would be significant especially in weaker economy conditions. Liu et al. (2017) suggested that the negative effect in stock prices would be more significant particularly for those companies that are more responsive to government policy changes. Hence, different factors, such as a country's economic conditions or company specific factors, can affect the magnitude of the impact of political risk on stock price performance.

According to Kim and Mei (2001) political developments is also connected to the volatility of stock markets; an increase in political risk increases volatility. They studied the Hong Kong stock market during 1989 to 1993. This is compatible with both studies of Pástor and Veronesi (2012 & 2013) as they showed evidence of increasing stock volatility as political uncertainty builds up. Additionally, Kim and Mei (2001) concluded the influence of bad news is more significant on volatility compared to good news. Therefore, political risk, and especially negative information, has been shown to affect market volatility as well.

Lehkonen and Heimonen (2015) showed evidence of gaining higher returns as political uncertainty decreases. Their research focused on emerging stock markets to study the influence of democracy and political risk on stock market performance. To analyse the stock market performance the MSCI Standard Total Return index of 49 emerging markets, for estimating political risk ICRG's Political Risk components and for democracy both, the Polity index of Polity IV and the democratic accountability index from the Political Risk Service were used. According to Diamonte, Liew and Stevens (1996) political risk has a greater impact on the stock markets in emerging markets compared to developed markets for which the market reaction towards decreasing and increasing political risk differs. For emerging markets average returns in decreasing political uncertainty conditions are significantly greater than in increasing political risk conditions. They conclude this difference to be more insignificant for the developed markets.

Gala et al. (2023) studied how political uncertainty influence financial markets globally. They studied the MSCI Global Market Indices and used a panel survey from the Ifo World Economic Survey to analyse political confidence. Contrarily, the results showed that higher political uncertainty led to higher average returns across countries. The increasing political uncertainty tends to influence financial markets globally even if it was originated locally. Thus, they suggested that political risk is priced by the financial markets globally.

In general, previous studies have shown there is a relation between political risk and stock market performance. Markets appear to price political uncertainty, and the general view is that an increase in political risk adversely affects stock prices. Observations of the influence of political risk on stock prices have been made worldwide; however, the impact and its magnitude are influenced by different factors such as market conditions or company specific characteristics. Hence, the war between Russia and Ukraine has presumably affected the

stock market performance in Finland as its effects have also been reflected in the state of political risk in the country.

3.3 The effectiveness of sanctions

International sanctions are means to promote change in the policies or actions of a state or a group of individuals by restricting economic, transport, communications, diplomatic or commercial relations (Ministry for Foreign Affairs of Finland 2023). The effectiveness of sanctions as a non-military action to promote policy change has been studied through research. Van Bergeijk (1989) analysed the factors that influence the effectiveness of economic sanctions in promoting change in the target's behaviour. The research suggested that stronger trade relationships between the countries in question increases the probability of a successful sanction. Additionally, the probability is higher when the target's political situation is more unstable, and the sanction period is shorter. Oechslin (2014) suggested that the efficacy of a sanction reduces when the time between the threat and the actual imposition increases. This provides time for the sanction target to adjust strategies to minimise the negative effects.

In addition to Van Bergeijk's (1989) view of strong trade linkages influencing the success of a sanction, there are results about sanctions affecting negatively on the trade relationship between the sanctioner and the target country (e.g., Afesorgbor, 2019, Doornich & Raspotnik, 2020 and Larch, Shikher, Syropoulos & Yotov, 2022). Doornich and Raspotnik (2020) examined how the economic sanctions the EU has imposed on the Russian Federation has affected trade relationships. Their descriptive study concluded the trade between Russia and the EU was negatively influenced by these sanctions. Afesorgbor (2019) studied the impact of economic sanctions on international trade by examining sanctions data during the years 1960 to 2009. The research supports the comprehension that sanctions decrease the bilateral trade but also concludes that the threat of sanctions leads to contrary results. The threat of sanctions can lead to stockpiling causing an increase in trade and thus, impairing the effectiveness of sanctions.

While the impact of economic sanctions on trade has been studied more, there is only limited research about the influence of international sanctions on financial markets. Ghasseminejad and Jahan-Parvar (2021) studied the reaction of Iranian stock market on imposition of

sanctions. They found evidence of significant negative market reaction to sanction announcements hence suggesting severe targeted sanctions to be an effective way to influence the behaviour of the sanction target. Biglaiser and Lektzian (2020) examined the effects sanctions have on national stock markets by using data from 66 countries through years 1990 to 2005. Their research as well showed sanctions can have a significant negative impact on stock markets and thus promote change in actions. Thus, there is evidence of the efficacy of sanctions and their relation to the stock markets. However, sanctions are often seen as less effective measure to promote policy change compared to military actions (Pape, 1998). Hence, the effectiveness of sanctions to promote change through financial markets is debatable.

The effectiveness is often delimited by the overuse of sanctions (Biglaiser & Lektzian, 2020). Kirat and Rezaee (2019) studied the stock market reaction to regulatory sanctions by examining sanctions the French financial regulator imposed between 2004 to 2017. They did conclude the market reaction to sanction announcements being negative. However, they suggested the efficiency of sanctions is impaired by the markets becoming accustomed to these announcements and penalties being insufficient. According to Ghasseminejad and Jahan-Parvar (2021) the first sanction is often the most efficient if multiple sanctions are imposed and the negative influence of financial sanctions is greater for companies that are more politically connected than for others.

Sanction impositions tend to affect negatively the trade relationship between the sanctioner and the target country. Furthermore, sanction announcements adversely affect stock markets as well. Even though the influence of sanctions on bilateral trade and stock markets is generally negative, the effectivity to promote policy change is often impaired by the overuse of sanctions. Because the sanctions imposed due to the Russia-Ukraine war have restricted trade with Russia, they have had consequences for the Finnish export industry in general but also especially for the Finnish technology industry. The sanctions targeted to the technology sector were therefore likely to adversely affect the companies within the industry. However, since so many sanctions have been imposed it may have weakened their effectiveness to promote change in Russia’s actions.

3.4 The impact of war on financial markets

Wars and military conflicts are known to influence financial markets by causing price movements of stocks (e.g., Choudhry, 2009 and Hudson & Urquhart, 2015). However, even an increase in the risk of war has been recognized to have a negative effect on financial markets (Rigobon & Sack, 2005). According to Guidolin and La Ferrara (2010) compared to internal conflicts, the impact of international conflicts on stock markets tends to be more severe. The uncertainty of the situation increases the volatility of stock markets; thus, the severity of a war event should also be reflected in the market reaction. (Schneider & Troeger, 2006).

Choudhry (2009) studied how the Dow Jones industrial average stock index reacted to the events of the World War II between years 1939 to 1945. According to the results, the events of the war, including both military and non-military, caused stock price movements and volatility of returns. The study suggested that stock prices often increase after an event if the investors interpret the news to be positive (e.g., victories) and on the contrary if the news is seen negative, for example as an indication of prolonging the war, the prices often decrease. Frey and Kucher (2001) studied the events of the World War II. They focused on the effect of the war events on German and Austrian government bond prices. In accordance with the results of Choudhry (2009), they found that the markets' interpretation of a war event was usually reflected in the direction of the asset price movement. The research of Hudson and Urquhart (2015) also focused on the effects of the major events of World War II on the British stock market. They found that rather than just interpreting the quality of a war event the markets react more strongly to negative events compared to positive events. In other words, the impact of a war event on stock market development is not necessarily always negative, but the direction of the price movement is often related to investors' interpretation of the nature of the event.

Schneider and Troeger (2006) studied the influence war events had on global financial markets from 1990 to 2000. Their study supports the perception that war related events can influence the markets by both increasing and decreasing stock prices. However, they concluded the market reaction toward a war related event is most often negative. Contradictive to the findings of both Choudhry (2009) and Frey and Kucher (2001) they argued that the direction of the market reaction is rather connected to the predictability of

the war event than distinguishing whether the event is considered as conflictive or cooperative. The volatility of stock market would be more likely to increase if the market expects the event to realise. (Schneider & Troeger, 2006) Hence, although the impact of a war event on asset prices can be negative or positive, in addition to investors' interpretation, the development can also be influenced by the predictability of the event. Furthermore, the influence of a negative event may also be more considerable compared to positive events.

Provably war events have an influence on the performance of stock markets. Wars are associated with a lot of uncertainty which in turn generally causes market volatility. Stock markets react not only to military events but also to non-military events and the event can cause a reaction in both directions. Instead, markets have been found to interpret the event's implications which is then reflected in the direction of the change, i.e., if the investors interpret the event to have negative consequences the prices decrease and vice versa. Also, the predictability of a war event can induce market volatility and influence the direction of the movement. Generally, information about war events is often scattered and published gradually, which may contribute to the heightened volatility. In addition, investors' tendency to overreact to unexpected events may contribute to explain why the predictability of an event affects the direction of the reaction.

3.5 The impact of the Russia-Ukraine war on stock markets

The effects of the Russia-Ukraine conflict on stock markets have been globally researched (e.g., Ahmed et al., 2022; Boubaker et al., 2023; Boungou & Yatié, 2022 and Lo et al., 2022). The results of the studies are analogous as the market reaction to the beginning of the crisis was mainly negative.

In a global analysis of the banking industry Boubaker et al. (2023) studied the stocks of 2,316 banks from 90 different markets. They observed significant negative stock returns for all continents on the event day implying market reaction to the event. However, the influence of the crisis on bank stocks was most severe in the European markets. Similar results were found in the research of Yousaf et al. (2022) where they studied the impact of the Russia-Ukraine conflict on stock markets of G20 and other selected countries. According to the study the negative market reaction to the crisis was global, but the impact was most severe in the European and Asian markets. In their study on energy firms' stocks Nerlinger and Utz

(2022) also found that the North American firms performed better compared to the European and Asian companies. Hence, Europe appears to be one of the regions which were the most negatively affected by the invasion.

Even though Ahmed et al. (2022) did observe negative stock price reactions to the conflict across Europe, the severity of the reaction varied between different countries. The study focused on the influence of the Russia-Ukraine crisis on the European stock markets by using the stocks of 587 companies from the STOXX Europe 600 index. The results showed that Finland, among Germany and France, was most adversely affected after the event day. Boungou and Yatié (2022) did a global research of stock market reactions to the conflict as they examined stock market indices from 94 countries. The world stock market indices reacted negatively to the conflict, but they found the markets of the countries bordering Ukraine and Russia experienced greater negative effects compared to others. Ahmed et al. (2022) results partly contradict this view because not all the countries which were most adversely affected were neighbours of Russia. Based on this, there have also been differences within Europe in how the outbreak of the war has affected the stock market of a country.

In addition to the geographical location, it has been recognized that a greater reliance on Russian commodities and a higher importance of the trade linkage between the countries has enforced the stock market reaction towards the invasion. Lo et al. (2022) studied the impact of the conflict on financial markets by examining world stock index data. Additionally, they studied how a country's dependence on Russian commodities affected the stock returns. They found that the most adversely affected were the countries with higher dependence on Russian commodities. Liadze et al. (2023) also justified that due to the strong trade relationships with Russia Europe has confronted greater economic costs compared to other continents.

Some studies have also examined the industry specific differences in the market reaction towards the invasion. Companies of different sizes and from varied industries were included into the research of Ahmed et al. (2022). The results showed the industries which experienced a negative reaction to the crisis were financial, telecommunication, consumer discretion, consumer staples, industrial and technology sectors. However, only the financial sector was adversely affected through the whole event window. The technology sector was adversely affected only on the pre-event window and reacted positively in the post-event window. Boubaker et al. (2023) noticed the bank stocks' reaction to the event being more

severe compared to the average stock markets. Nerlinger and Utz (2022) targeted their study on energy firms' stock performances. They performed a global study about the impact of the Russia-Ukraine conflict on 1,630 energy firms' stock returns. The cumulative average abnormal returns were in fact positive for companies within the energy sector. This conclusion is analogous to the research of Ahmed et al. (2022) where they noticed a positive reaction of energy the energy sector.

The impact of the Russia-Ukraine crisis on stock markets has been studied globally and the previous research have showed similar results. The reaction of the stock markets to the crisis was mainly negative, as could be expected. The negative market reaction to the conflict was global but most severe in Europe and Asia compared to other continents. The studies have suggested that a closer proximity to and a stronger trade relationship with Russia has increased the negative effects the crisis has created for a country and its stock market. On the other hand, some variation was found in the market reactions between different industries. The financial industry appeared to be the most adversely affected industry due to the invasion, but the negative effects extended to other industries as well.

4 Data and methodology

The Russia-Ukraine war broke out on 24th of February 2022 when a "special military operation" was announced by Russian President Vladimir Putin. Russian troops were ordered into Ukraine and the capital, Kyiv, among the second-largest city of the country, Kharkiv, were attacked. (CNN 2023, Reuters 2022, The New York Times 2023) The situation between the two countries had tightened throughout the preceding years after Russia's annexation of Crimea in 2014 leading to the current conflict (Shyam, 2023).

The Russian actions were heavily condemned worldwide; thus, several sanctions have been imposed by the United States, the European Union, and other G-7 states to dissuade Russia from the conflict. The imposed sanctions have covered restrictions on the financial sector and on trade. For instance, sanctions have considered restrictions for Russia on SWIFT transactions and the trade of electronics and technologies. (Shyam, 2023) The invasion has been followed by numerous war events and despite the actions against Russia the war continues to unfold (CNN 2023, The Guardian 2023). This section covers the description of the data and the methodology used in the research. Overall, this research mainly follows the event study methodology proposed by MacKinlay (1997) and Wells (2004).

4.1 Event definition

This study examines the influence of the events of the Russia-Ukraine war on the stock prices of Finnish technology industry companies and approaches the topic by studying multiple war related events during the first year of the conflict. Selecting the event of interest and determining the relevant time period to study (the event window) are the first steps of an event study. As multiple events might take place simultaneously or the publication of information might be dispersed, separating concurrent events, and specifying the relevant event window might be challenging. (Wells, 2004) The time frame mentioned includes several war related events including military and non-military events. Therefore, the issue of separating concurrent events provides a challenge.

The aim was to find the most significant events during the specified time frame in a way that the event days do not overlap. Different sources depicting the timeline of the events during

the first year of the conflict were searched to define the event days for the study (e.g., CNN 2023, Reuters 2023, The New York Times 2023 & European Council 2023). Certain major events, for example Russia claiming the control of Kherson in March 2022, were left out of the scope of the study due to concurrent events for which estimating the impact of a single event would have been complicated. Ultimately, 16 different events in total were selected under research. The events selected for the study and the allocation to military and non-military event types are presented in Table 1.

Event day	Event	Event type
24.2.2022	Russia invades Ukraine and attacks Kyiv and Kharkiv	military
2.3.2022	Russia seizes the Ukrainian city Kherson and the Zaporizhzhia nuclear plant	military
9.3.2022	Russia attacks the Mariupol maternity hospital	military
16.3.2022	Russia bombs the Ukrainian Mariupol theater	military
23.3.2022	EU approves additional 500M€ support package to Ukraine	non-military
14.4.2022	Ukraine has hit the Russian missile cruiser Moskva causing the ship to sink	military
3.5.2022	Putin threatens retaliatory sanctions to the West in response to the sanctions imposed on Russia	non-military
16.5.2022	Russia takes control of Mariupol	military
5.9.2022	Russia halts gas supply to Europe until the sanctions imposed over the Ukraine conflict are lifted	non-military
21.9.2022	Putin announces partial mobilization and threatens nuclear retaliation	non-military
10.10.2022	Russian attacks destroy 30% of Ukrainian power stations leading to major blackouts in the country	military
17.10.2022	The United States provides long-range missiles to support Ukraine	non-military
9.11.2022	Russian forces are forced to withdraw from the city of Kherson	military
21.12.2022	Ukrainian president Volodymyr Zelenskyi visits the White House	non-military
25.1.2023	The United States and Germany announce to send tanks to support Ukraine	non-military
20.2.2023	The US president Joe Biden visits Kyiv	non-military

Table 1. Event days and type of events (Based on CNN 2023, European Council 2023, Associated Press 2023, The New York Times 2023 & Reuters 2023).

Previous research has shown that war events tend to have an influence on stock markets and even the non-military events can cause movements in stock prices (e.g. Choudhry, 2009). One of the objectives of the study was to examine whether the type of the event had an impact on the market reaction. Thus, the selected events were further divided into two categories: military events and non-military events (see Table 1). The military events

category includes combat related events such as attacks, bombings, and counteroffensive measures whereas the category non-military events consist press statements, state visits and other acts of support for Ukraine. The categories include equal number of events; eight in both categories.

A timeline of the events along with the development of the OMXH25 index price is presented in Appendix 1. At the beginning of the timeline, considerable drops in the index price follow the first two events of the war; the Russian invasion of Ukraine in February and the seizes of the city of Kherson and the Zaporizhzhia nuclear power plant in the beginning of March. After this, the course changed to an upward trend although some fluctuation is noticeable near the events. There is also a noticeable drop in the price after Putin threatened of retaliatory sanctions in the beginning of May. Also, shortly after the second event in May, there is a drop in the price after Russia has taken the control of Mariupol. Again, a similar consequence in the price can be observed after the announcement by Putin of a partial mobilization in September. After the events in October there was an upward trend in the price. Also, a noticeable rise in the price can be perceived after the event in November when Russia had to withdraw from Kherson. According to the timeline, the events during end of 2022 and beginning of 2023 did not lead to any significant fluctuation of the index price. The timeline shows the events at the beginning of the war caused more turmoil in the market and the price of the index is more stable towards the end of 2022.

4.2 Data and descriptive statistics

The second step of an event study is to recognize which firms might be impacted by the event, i.e. define the companies to study (Wells, 2004 and MacKinlay, 1997). A strong trade linkage with Russia has provably had a negative influence on the market reaction of a region to the Russia-Ukraine conflict (Liadze et al., 2023). Considering the strong trade relationship between Finland and Russia and the significant investment through exports of the Finnish technology industry companies to Russia, the consequences of the conflict for the stocks of these companies and the country's overall economy are unsettling. Consequently, the Finnish companies within the technology industry were identified to potentially being impacted by the conflict.

The companies to study were chosen in a way that different main business lines of the technology industry were represented in the data. Additionally, for a company to be included in the research its stock had to be listed in the Nasdaq OMX Helsinki stock exchange. In total, the stocks of 16 publicly traded companies were specified under research. Table 2 presents the companies of which stocks are included in the study.

Company	Stock	Business line
Bittium Oyj	BITTI	Electronics and electrical industry
Cargotec Oyj	CGCBV	Machine and metal industry
Digia Oyj	DIGIA	Information technology
Digitalist Group	DIGIGR	Information technology
Fiskars Group	FSKRS	Machine and metal industry
Gofore Oyj	GOFORE	Information technology
Innofactor Oyj	IFA1V	Information technology
Kone Oyj	KNEBV	Machine and metal industry
Konecranes Oyj	KCR	Machine and metal industry
Metso Oyj	METSO	Machine and metal industry
Nokia Oyj	NOKIA	Electronics and electrical industry
Tecnotree Oyj	TEM1V	Information technology
TietoEVRY Oyj	TIETO	Information technology
Vaisala Oyj	VAIAS	Electronics and electrical industry
Valmet Oyj	VALMT	Machine and metal industry
Wärtsilä Oyj Abp	WRT1V	Machine and metal industry

Table 2. Technology industry companies included in the study (Based on LSEG Workspace data 2024)

As the research includes Finnish companies, the OMXH25 index was chosen to represent the market return. The overall dataset includes daily observations of the total return index prices beginning from the 29th of September 2021 until 23rd of February 2023. In addition to the daily price changes, the total return index prices consider the possible stock splits and cash payments, e.g. dividends. Thus, it provides a more accurate performance measure compared to price return. (Vaihekoski, 2022, 202) Therefore, the daily total return index

prices were used to calculate the historical daily returns for each stock and the index. The overall data was collected from the LSEG Workspace database. According to Wells (2004) using natural logarithms should be preferred over percentage changes in order to avoid the arithmetic anomaly. Also, the logarithmic returns are better normally distributed and can be cumulated through time (Vaihekoski, 2022, 205). Therefore, the returns were calculated using the logarithmic returns followingly:

$$r_t = ln\left(\frac{p_t}{p_{t-1}}\right) \quad (2)$$

Where r_t is the return at time t and p is the price of the share (Vaihekoski, 2022, 205). The descriptive statistics of the calculated daily returns are shown in Table 3.

Volatility reflects the dispersion of stock returns, and a high volatility is an indication of higher fluctuation in stock returns (Vaihekoski, 2022, 208). As can be seen from Table 3 the standard deviation (3,174%) and the variance (0,101%) of stock returns was highest for Tecnotree during the research period. This indicates that the stock was most volatile within the sample. The company's stock did obtain the greatest one-day return (16,379%) but also the largest negative one-day return (-17,499%). The stock of Tietoevry resulted as least volatile with the lowest values for both standard deviation (1,479%) and variance (0,022%). Konecranes obtained the second best one day return (15,865%) whereas the second largest negative one day return (-16,908%) occurred for Innofactor. For most of the companies within the sample the average of one-day returns was negative. The average return was lowest for Tecnotree (-0,176%) and highest for Metso (0,085%).

	Min	Max	Mean	Median	Strandard Deviation	Variance	Count
OMXH25	-4,728	3,995	-0,005	0,074	1,300	0,017	356
BITTIUM	-7,444	11,239	-0,086	-0,112	2,077	0,043	356
CARGOTEC	-10,391	14,159	0,035	0,183	2,793	0,078	356
DIGIA	-7,852	6,325	-0,016	0,000	1,908	0,036	356
DIGITALIST	-11,288	13,900	-0,126	0,000	2,778	0,077	356
FISKARS	-9,681	8,328	-0,023	0,000	2,164	0,047	356
GOFORE	-7,503	8,866	0,074	0,000	2,315	0,054	356
INNOFACTOR	-16,908	9,726	-0,023	0,000	2,122	0,045	356
KONE	-5,564	6,546	-0,046	-0,156	1,897	0,036	356
KONECRANES	-8,326	15,865	-0,013	0,027	2,550	0,065	356
METSO	-8,912	10,803	0,085	0,101	2,515	0,063	356
NOKIA	-7,921	8,883	-0,015	0,011	1,827	0,033	356
TECNOTREE	-17,499	16,379	-0,176	-0,426	3,174	0,101	356
TIETOEVRY	-6,529	5,699	0,055	0,075	1,479	0,022	356
VAISALA	-8,143	10,852	0,042	0,000	2,342	0,055	356
VALMET	-6,540	9,713	0,014	0,063	2,043	0,042	356
WÄRTSILÄ	-11,619	10,700	-0,015	-0,043	2,477	0,061	356
Average	-9,226	10,116	-0,014	-0,012	2,221	0,051	356

Table 3. Descriptive statistics of the dataset (Based on LSEG Workspace data 2024). Statistics of the returns are in percentages.

During the first year of the war, the largest drops in the OMXH25 index returns occurred around the time the Russia-Ukraine war broke out (visible in Figure 1). The one day return of the index on 24th of February 2022 was -3,910% and shortly after the largest negative return (-4,728%) during the research period occurred on 1st of March 2022. Also, the highest positive one-day return (3,995%) for the index during the research period occurred shortly after the invasion, on 9th of March 2022. This reflects the higher fluctuation in the returns of the index during the time close to the invasion.

4.3 Methodology

After identifying the event day and the affected firms, the normal returns, i.e., the normal change in stock prices, were estimated. The normal returns are calculated based on the period preceding the event and therefore do not contain the influence of the event on return. (MacKinlay, 1997). This period is referred to as the estimation window and most commonly consists of observations preceding the event window. As the methodology aims to measure the immediate reaction to an event, i.e. short-term impact, a relatively short period of time can be used. (Campbell et al., 1997, 149-151) To get adequate estimations, the estimation period should include 100 days or more (Armitage, 1995). Thus, in align with Keleş (2023) and Obi, Waweru and Nyangy (2023) an estimation period of 100 days was used in this research as well.

In order to detect anticipatory or delayed reactions, MacKinlay (1997) suggests expanding the event window from the exact event day only. Thus, for every event the event window was set to five including the event day plus two days prior and after. The event-windows were kept compact to avoid overlapping since multiple events was included in the research.

4.3.1 Estimating the normal returns

There are different methods for the estimation of normal returns or in other words the expected returns. For instance, the mean daily returns of a company's stock could be used in the mean-adjusted model. Here, the average is compared to the actual returns which occur. Alternatively, the market-adjusted model utilizes the market's mean return. Here, the company's actual stock returns during the event window are compared to the average return of the market, for example of an index. (Wells, 2004) Or, in the market model, the return of an individual stock is calculated in relation to the market's return. The advance of the market model is the increasing ability to identify market reaction to an event as part of the variation is reduced. (MacKinlay, 1997) Also, Wells (2004) considers the market model to be more sophisticated for estimating the normal returns as it includes adjustment for systematic risk. Therefore, the market model was chosen to be used in this study.

Firstly, the beta and alpha of each stock was calculated. In order to estimate the beta and alpha values used in the calculations, risk-free rate was deducted from the daily returns of

each stock and the index. Euribor 1-month was used as the risk-free rate in the research. Then, the normal returns were estimated in relation to a market portfolio, i.e., the OMXH25 index, returns. The following formula was used to estimate the normal returns:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it}$$

$$E(\varepsilon_{it} = 0) \qquad var(\varepsilon_{it}) = \sigma_{\varepsilon_i}^2 \qquad (3)$$

Where R_{it} is the period t return of investment i, α_i is the alpha of investment i, β_i is the beta of investment i, R_{mt} is the period t return of the market portfolio, ε_{it} is the disturbance term assumed equal to zero and $\sigma_{\varepsilon_i}^2$ is considered as a model parameter (MacKinlay, 1997).

4.3.1 AR and AAR calculations

After estimating the normal returns for all stocks within the sample, the abnormal returns (AR) were calculated. The AR indicates the impact of the event on stock prices and whether the reaction was negative or positive. The abnormal returns are calculated based on the differences between the normal returns and the actual returns. (Wells, 2004) The abnormal returns were calculated followingly:

$$AR_{it} = R_{it} - \alpha_i - \beta_i R_{mt} \qquad (4)$$

Where R_{it} is the previously estimated period t return of investment i, α_i is the alpha of investment i, β_i is the beta of investment i, R_{mt} is the period t return of the market portfolio (MacKinlay, 1997).

Then, the average abnormal returns (AAR) are calculated as the average of these abnormal returns during the event window (MacKinlay, 1997). The abnormal returns were aggregated across all securities in order to obtain the average abnormal returns. Both AR and AAR were

compounded for each day within an event window. The AAR was calculated with following formula:

$$AAR_t = \frac{1}{N}\sum_{i=t}^{N} AR_{it} \quad (5)$$

Where AAR_t is the period t average abnormal return, N is the number of cases and AR_{it} is the previously compounded abnormal return for investment i (MacKinlay, 1997).

4.3.2 CAR and CAAR calculations

By calculating the cumulative abnormal returns (CAR), it is possible to examine the abnormal returns through time. This provides advantages with events where the specification of the exact event day is problematic (Wells, 2004). In order to calculate the cumulative abnormal returns, the abnormal returns need to be summed over time (MacKinlay, 1997). Thus, to calculate the CAR the AR results were aggregated through time for each day in an event window followingly:

$$CAR_i(t_1, t_2) = \sum_{t=t_1}^{t_2} AR_{it} \quad (6)$$

Where $CAR_i(t_1, t_2)$ is the cumulative abnormal return for investment i of the determined time period and AR_{it} is the previously compounded abnormal return for investment i (MacKinlay, 1997).

Finally, the cumulative average abnormal returns can be calculated as the average of the CAR. (MacKinlay, 1997). Therefore, the cumulative abnormal returns were aggregated across all securities to calculate the cumulative average abnormal returns followingly:

$$CAAR(t_1, t_2) = \frac{1}{N}\sum_{i=1}^{N} CAR_i(t_1, t_2) \quad (7)$$

Where $CAAR(t_1, t_2)$ is the cumulative average abnormal return of the determined time period and $CAR_i(t_1, t_2)$ is the cumulative abnormal return for investment *i* in the determined time period (MacKinlay, 1997).

Ultimately, all the calculations were replicated for each event chosen under research. Also, averages of the AAR and CAAR results of all events by event types were calculated to examine the differences of the impact of different event types.

4.3.3 Significance testing

Finally, the significance of the results was estimated. For the statistical significance tests of the average abnormal returns the following formula was used:

$$\frac{\sqrt{N} \times AAR_t}{\sqrt{\sigma^2(AR_{it})}} \sim N(0,1) \quad (8)$$

Where AAR_t is the average abnormal return, σ^2 is the variance, AR_{it} is the abnormal return and N is the number of cases (Vaihekoski, 2022, 248).

According to Vaihekoski (2022, 249) the variance can be estimated in numerous ways. At its simplest, it is the variance of the (cumulative) abnormal excess returns. The variance was calculated as the variance of the abnormal returns within an estimation window. The t-ratio was calculated by dividing the AAR with standard error. Also, the p-value of the test statistic was calculated.

The significance test for cumulative average abnormal returns was made followingly:

$$J_1 = \frac{CAAR(t_1,t_2)}{\sqrt{\sigma^2(t_1,t_2)}} \sim N(0,1) \quad (9)$$

Where $CAAR(t_1, t_2)$ is the cumulative average abnormal return in the determined time period, σ^2 is the variance and N is the number of cases (Vaihekoski, 2022, 249). Again, the p-value of the test statistic (J_1) was calculated.

4.3.4 Cumulative returns

Because the war continues to unfold to this day, it was examined how the Finnish technology industry companies have performed afterwards. The long-term performance of the companies was examined by calculating the cumulative returns of the stocks and the index. Since this part of the study focused on the subsequent time, the cumulative returns were calculated during a period of one year after the last event in this study. More precisely, the calculations include data from 1st of March 2023 to 29th of February 2024.

As when examining the individual events, correspondingly the daily total return index prices were used in this part of the study. According to Vaihekoski (2022, 205), logarithmic returns are superior to percentage returns as they can be cumulated through time. Thus, the logarithmic returns were calculated and then cumulated through time for four different time periods: 1 year, 6 months, 3 months and 1 month.

The cumulative returns were calculated followingly:

$$R_c = [\,[\,(1 + r_t) \times (1 + r_{t+1}) \times \ldots \times (1 + r_n)\,] - 1\,] \times 100\% \qquad (10)$$

Where R_c is the cumulative return of the period, r_t is the return at time t and n is the number of periods (based on Vaihekoski, 2022, 205). Test-statistics were calculated for the cumulative returns as well. Also, the analysis includes calculations of the excess returns of each company's cumulative returns compared to the market index.

5 Results

The empirical results of the research are presented in this section. At first, the average abnormal returns and the cumulative average abnormal returns of the military events are presented. Then, similar results for the non-military events are shown. For all the events, the daily average abnormal returns are presented for each day within the event window including two preceding days, the event day and two subsequent days. The cumulative average abnormal returns are demonstrated with different time periods within the event windows with t_1 representing the start date and t_2 the last date considered in the CAAR calculation. Then, averages of the AAR and CAAR results for both event types are presented and the event types are compared. After this, the long-term performance is addressed through the results of the cumulative returns of four different periods after the latest event in the study. Lastly, the section provides a discussion of the results.

5.1 Military events

The results of the average abnormal returns (AAR) and the t-values for each day within the event windows for the military events are presented in Table 4. According to the AAR results there was a significant reaction of the Finnish technology industry companies to the event on 24th of February 2022 and the reaction was positive (2,128%). Also, the AAR was positive (1,261%) and significant two days after the event day. The AAR results show the returns fluctuated from positive to negative within the event window indicative of a higher volatility.

Additionally, for the event on 14th of April 2022 the AAR results show a significant positive reaction (1,077%) on the day of the event. During the event window of this event the AAR was negative during the pre-event window and positive in the post-event window. However, none of the other AAR results of this event appeared significant. According to the AAR results, in addition to these two events there was no statistically significant reaction to any other military event on the day the event occurred. From all the military events, the AAR on the event day was negative for two events and positive for six events.

Military events			
Event day	**Event window**	**AAR**	**t-value**
24.2.2022	-2	0,732 %	1,538
	-1	-0,345 %	-0,726
	0	2,128 %	4,475***
	1	-0,751 %	-1,579
	2	1,261 %	2,652**
2.3.2022	-2	1,155 %	2,354**
	-1	0,754 %	1,537
	0	0,015 %	0,031
	1	0,541 %	1,102
	2	0,203 %	0,414
9.3.2022	-2	-0,014 %	-0,029
	-1	0,423 %	0,850
	0	-0,608 %	-1,222
	1	-1,285 %	-2,582**
	2	-0,563 %	-1,132
16.3.2022	-2	-0,919 %	-1,836*
	-1	-0,051 %	-0,103
	0	0,227 %	0,453
	1	-0,468 %	-0,935
	2	0,368 %	0,735
14.4.2022	-2	-0,107 %	-0,216
	-1	-0,281 %	-0,565
	0	1,077 %	2,161**
	1	0,258 %	0,518
	2	0,014 %	0,028
16.5.2022	-2	0,673 %	1,308
	-1	-0,042 %	-0,081
	0	0,539 %	1,047
	1	0,349 %	0,678
	2	0,383 %	0,744
10.10.2022	-2	1,584 %	3,442***
	-1	-0,005 %	-0,011
	0	-0,351 %	-0,762
	1	-0,102 %	-0,221
	2	-0,198 %	-0,430
9.11.2022	-2	-0,183 %	-0,367
	-1	0,091 %	0,183
	0	0,003 %	0,005
	1	1,263 %	2,526**
	2	1,273 %	2,545**

* p<=0.1; ** p<=0.05; *** p<=0.01

Table 4. Average abnormal returns (AAR) of the military events.

Although for most military events the AAR is non-significant on the event day, the results do indicate reactions during the event windows. For the event on 2nd of March 2022 the AAR is non-significant on the event day and appears only slightly positive (0,015%). However, two days before the day of the event the AAR is significant and appears positive with 1,155%. All other AAR results also resulted positive within this event window even if non-significant.

Contrarily, one day after the event on 9th of March 2022 the AAR is significant and negative (-1,285%). This was also the greatest negative AAR for any day within the event windows of any military event. On the event day the AAR is also negative (-0,608%) but appears non-significant. Also, the AAR is negative on most days of this event window.

For the event on 16th of March 2022 the positive AAR was non-significant (0,227%) on the event day. Two days before the event the AAR results show a significant negative reaction (-0,919%). Overall, the development in the pre-event window appears negative.

For the event on 10th of October 2022 the AAR two days before the event day was significant and positive with 1,584%. The AAR was however negative for all the other days within the event window of this event, even if non-significant.

Significant AAR's can be observed in the post-event window for the event on 9th of November 2022. The AAR at t_1 and t_2 was positive with 1,263% and 1,273%, respectively. On the event day the AAR is only slightly positive (0,003%) and thus non-significant. For most days of this event window, the AAR resulted positive.

All the AAR results within the event window of the military event on 16th of May 2022 resulted non-significant. As for most of the military events there were only single days for which the AAR result was significant and the direction of the average abnormal return varied within the event windows, no clear implications of market reactions to these events could be made based on the AAR results only. More statistically significant results were obtained for the cumulative average abnormal returns of the military events. The results of the cumulative average abnormal returns (CAAR) and the test-statistic values are presented in Table 5. These cumulative average abnormal returns are presented for different time periods within the event windows.

Military events			
Event day	**[t1,t2]**	**CAAR**	**J1**
24.2.2022	[-2,-1]	0,386 %	0,574
	[-1,+1]	1,032 %	2,170**
	[0,0]	2,128 %	4,475***
	[0,+1]	1,377 %	2,048**
	[+1,+2]	0,510 %	0,759
2.3.2022	[-2,-1]	1,909 %	2,752***
	[-1,+1]	1,310 %	2,671***
	[0,0]	0,015 %	0,031
	[0,+1]	0,556 %	0,801
	[+1,+2]	0,744 %	1,072
9.3.2022	[-2,-1]	0,409 %	0,581
	[-1,+1]	-1,470 %	-2,954***
	[0,0]	-0,608 %	-1,222
	[0,+1]	-1,893 %	-2,690***
	[+1,+2]	-1,848 %	-2,627***
16.3.2022	[-2,-1]	-0,970 %	-1,371*
	[-1,+1]	-0,293 %	-0,585
	[0,0]	0,227 %	0,453
	[0,+1]	-0,241 %	-0,341
	[+1,+2]	-0,100 %	-0,142
14.4.2022	[-2,-1]	-0,389 %	-0,552
	[-1,+1]	1,054 %	2,115**
	[0,0]	1,077 %	2,161**
	[0,+1]	1,335 %	1,895**
	[+1,+2]	0,272 %	0,387
16.5.2022	[-2,-1]	0,632 %	0,867
	[-1,+1]	0,846 %	1,644**
	[0,0]	0,539 %	1,047
	[0,+1]	0,888 %	1,220
	[+1,+2]	0,732 %	1,006
10.10.2022	[-2,-1]	1,579 %	2,426***
	[-1,+1]	-0,458 %	-0,994
	[0,0]	-0,351 %	-0,762
	[0,+1]	-0,453 %	-0,695
	[+1,+2]	-0,300 %	-0,460
9.11.2022	[-2,-1]	-0,092 %	-0,130
	[-1,+1]	1,357 %	2,714***
	[0,0]	0,003 %	0,005
	[0,+1]	1,266 %	1,790**
	[+1,+2]	2,537 %	3,586***

* p<=0.1; ** p<=0.05; *** p<=0.01

Table 5. Cumulative average abnormal returns (CAAR) of the military events.

For the first event, on 24th of February 2022, the CAAR result from t_{-1} to t_{+1} show a significant change in returns (1,032%). Also, the CAAR from t_0 to t_{+1} was positive (1,377%). However, according to both AAR and CAAR results the abnormal return at the event day (t_0) was most substantial. Even though the direction of the AAR varied through the event window, the results combined indicate a positive reaction to this military event when the primary invasion of Russia on Ukraine occurred. Additionally, as the positive reaction was greater on the day of the event, the results suggest the event day had a higher influence on the returns compared to the surrounding days.

The CAAR results show a significant reaction during the pre-event window to the event on 2nd of March 2022. The CAAR was positive from t_{-2} to t_{-1} and from t_{-1} to t_{+1} (1,909% and 1,310%, respectively) which are in line with the AAR results. In addition to the result on the event day, the CAAR results in the post-event window (t_0 to t_{+1} and t_{+1} to t_{+2}) resulted also non-significant. Based on the AAR and CAAR results combined, the positive market reaction to the military event when Russia seized Kherson and the Zaporizhzhia nuclear power plant appeared anticipated.

Contrarily, the reaction towards the event on 9th of March 2022 appeared to be negative and the CAAR was significant for several time periods within the event window. The CAAR was significant from t_{-1} to t_{+1} (-1,470%), t_0 to t_{+1} (-1,893%) and t_{+1} to t_{+2} (1,848%). Based on the AAR results, the most significant day seemed to be the day following the event (t_{+1}), but the CAAR results show that other days also influenced the returns. Nevertheless, the results suggest there was a negative reaction to the event when Russia attacked the Mariupol maternity hospital. Additionally, this event had the greatest negative impact on the returns of all military events.

For the event on 16th of March 2022 the CAAR was significant only in the pre-event window (from t_{-2} to t_{-1}) and resulted negative (-0,970%). Hence, according to both AAR and CAAR results, the market reaction to this event also appeared anticipated. However, both results are significant only at the 10% level and although the results were negative through most of the event window, the AAR and CAAR results combined suggest the event of Russian bombing the Mariupol theatre would not have had a considerable impact on the market. However, the impact which the event had, was negative.

The CAAR results indicate a positive reaction to the event on 14th of April 2022. In addition to the abnormal return on the event day, the CAAR was significant from t_{-1} to t_{+1} (1,054%) and t_0 to t_{+1} (1,335%). Hence, even though the AAR results showed a significant reaction only on the event day, the CAAR results suggest the days surrounding did also have an influence on the returns. Thus, the event day and the days surrounding appear to have had a significant impact on the returns and the market reaction to the event of sinking of the Russian missile cruiser Moskva was positive.

From Table 5 the only significant CAAR result for the event on 16th of May 2022 can be observed. The CAAR was 0,846% for the time window from t_{-1} to t_{+1} which indicates a positive reaction to the event. Even though the CAAR was significant at 10% level, since this was the only significant result for the event when Russia took the control of Mariupol, the AAR and CAAR results together suggest that this event did not have a considerable impact on the stocks.

For the military event on 10th of October 2022 the only significant CAAR result is for the period from t_{-2} to t_{-1}. This CAAR is positive (1,579%) but conversely all the other CAAR results for this event window are negative. Since the positive returns in the pre-event window change to a negative course later, the results indicate higher volatility during the event window. Overall, the results show that there was a positive market reaction before the event when Russian attacks led to major blackouts in Ukraine but at the time of the event the influence was negative but not significant.

The CAAR results indicate a positive reaction to the event on 9th of November 2022. CAAR was significant for multiple time periods, from t_{-1} to t_{+1} (1,357%), t_0 to t_{+1} (1,266%) and t_{+1} to t_{+2} (2,537%). The AAR and CAAR results combined show that the days surrounding the event day had an influence on the stocks but also that the impact intensified over the days. However, the day of the event does not appear significant. Based on the results, the event when Russia was forced to withdraw from Kherson caused a positive reaction.

Figure 3 illustrates the CAAR of each day within the event windows of the military events. From the figure it can be observed that the military event on 9th of March 2022 had the greatest adverse effect on the stock returns of the technology industry companies from all the military events studied. The figure also shows the stable negative development of the returns during the time of the military event that occurred on 16th of March 2022.

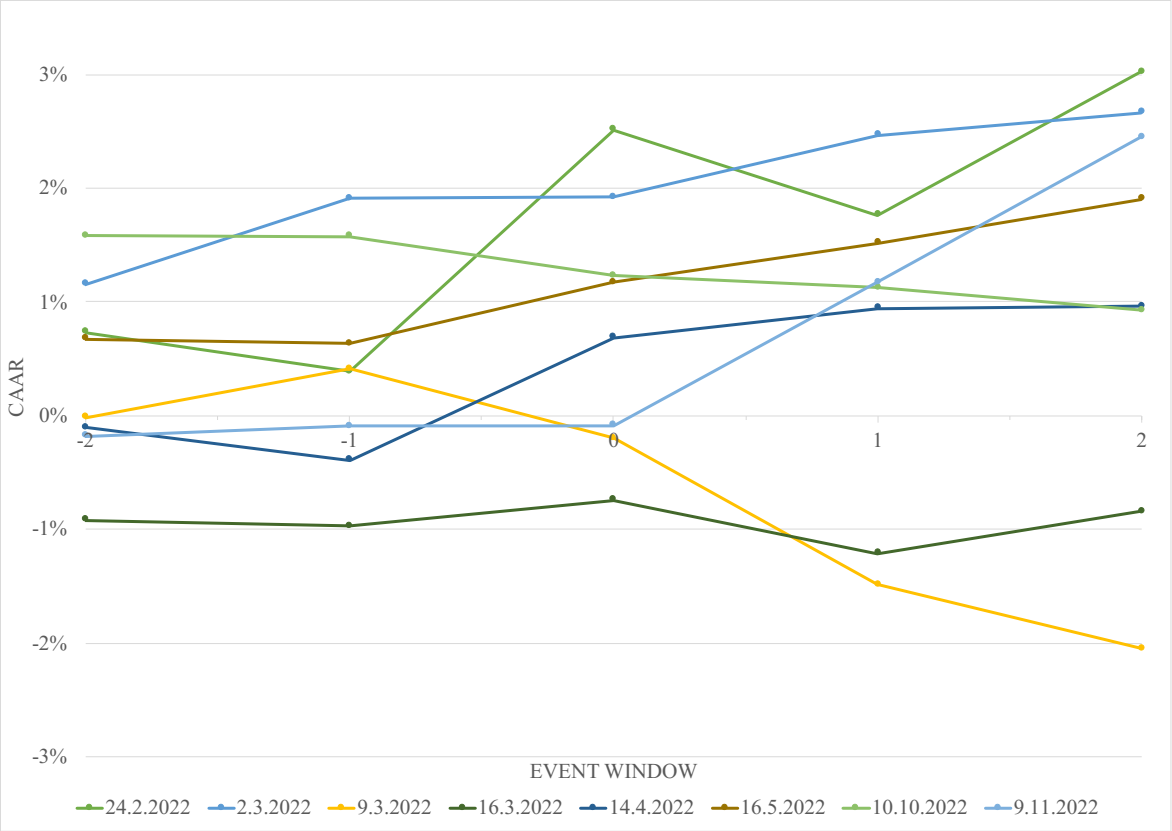


Figure 3. Cumulative average abnormal returns of the military events during the event window.

Furthermore, from Figure 3 it can be observed that the impact of all other military events within the event windows was positive. For instance, the impact of the military event on 9th of November 2022 and the positive change in returns after the event date are clearly visible in the figure. Also, the volatility during the event window of the 24th of February 2022 event can be distinctly observed.

5.2 Non-military events

The results of the average abnormal returns (AAR) and the test-statistics for each day within the event windows for the non-military events are presented in Table 6. According to the AAR results there were three non-military events which had a significant influence on the returns of the technology industry companies on the day of the event. On the event date of 5th of September 2022, the AAR was negative (-1,100%) and significant which indicates that

the event had an immediate adverse effect on returns. As the AAR for all other dates within the event window resulted non-significant the results indicate that no other individual date influenced significantly.

For the event on 21st of December 2022 the event date AAR was significant and positive (1,075%) conversely indicating that the event had a positive influence on returns. Regarding this event, the AAR was also significant during the pre-event window at t_{-2} (-1,078%) and t_{-1} (-1,414%). The results suggest that before the event date the impact has been negative but on the event date there was a clear positive reaction which again shows higher volatility during the event window.

The AAR results also show a significant impact of the non-military event on 20th of February 2023 on returns. The AAR was significant on the event date and indicates a negative influence (-0,987%) on returns. As no other AAR resulted significant for this event window the results imply that no other individual date had a distinct impact on returns.

Similar to the results of the military events, although the AAR is non-significant on the event day of all other non-military events, the results indicate significant effects during the event windows. From all the non-military events, the AAR on the event day was negative for four events and positive for also four events. The positive AAR was non-significant on the event date of 23rd of March 2022 but in the post-event window the AAR results indicate a significant negative influence on returns. The AAR at t_{+1} was -1,196% and at t_{+2} -1,539%, both significant, which suggests an adverse effect of the event. Since the abnormal development occurred in the post-event window only, it indicates a delayed reaction to the event.

On the contrary, based on the AAR results only, the reaction towards the event on 3rd of May 2022 appears slightly anticipated. Even though the negative AAR is non-significant on the day of the event, the result is significant one day before (-1,515% at t_{-1}). For this event, no other AAR resulted significant.

Non-Military events

Event day	Event window	AAR	t-value
23.3.2022	-2	0,015 %	0,030
	-1	-0,596 %	-1,211
	0	0,348 %	0,707
	1	-1,196 %	-2,433**
	2	-1,539 %	-3,129***
3.5.2022	-2	0,364 %	0,726
	-1	-1,515 %	-3,016***
	0	-0,262 %	-0,521
	1	0,469 %	0,935
	2	-0,206 %	-0,409
5.9.2022	-2	-0,509 %	-1,066
	-1	0,290 %	0,606
	0	-1,100 %	-2,303**
	1	0,196 %	0,409
	2	-0,368 %	-0,771
21.9.2022	-2	0,094 %	0,195
	-1	-0,233 %	-0,485
	0	-0,805 %	-1,679
	1	-0,587 %	-1,223
	2	0,331 %	0,691
17.10.2022	-2	1,114 %	2,407**
	-1	-0,516 %	-1,114
	0	0,001 %	0,002
	1	0,786 %	1,699
	2	1,087 %	2,348**
21.12.2022	-2	-1,078 %	-2,358**
	-1	-1,414 %	-3,093***
	0	1,075 %	2,352**
	1	0,681 %	1,490
	2	-0,127 %	-0,279
25.1.2023	-2	-0,441 %	-0,957
	-1	-0,112 %	-0,242
	0	0,284 %	0,617
	1	-0,179 %	-0,388
	2	1,247 %	2,707**
20.2.2023	-2	0,259 %	0,565
	-1	-0,111 %	-0,242
	0	-0,987 %	-2,158**
	1	-0,223 %	-0,489
	2	-0,459 %	-1,003

* p<=0.1; ** p<=0.05; *** p<=0.01

Table 6. Average abnormal returns (AAR) of the non-military events.

The AAR on the event day on 17th of October 2022 was near zero which shows that the event day did not cause a reaction on the market. However, AAR is significant two days before (t_{-2}) and two days after (t_{+2}) the day of the event. Both results suggest there was a positive influence on returns but since these were the only significant results and the direction of the abnormal return varied within the event window, no clear suggestions can be made about the impact based on the AAR results alone.

For the event on 25th of January 2023 the AAR on the event date is positive with 0,284%, albeit non-significant. The AAR results show a negative development in the pre-event window and one day after the event, but these results are also non-significant. However, the AAR two days after the event (t_{+2}) was significant and shows a positive reaction (1,247%). The result may indicate of a delayed reaction to the event.

All the AAR results within the event window of the non-military event on 21st of September 2022 resulted non-significant indicating that no individual date impacted considerably. Even though significant AAR results were obtained more for the non-military events, compared to the military events, the CAAR results still provide further understanding of the impacts of different events on returns. The results of the cumulative average abnormal returns of the non-military events are presented in Table 7. These CAAR results are presented for similar time windows as for the military events.

Regarding the event on 23rd of March 2022 the CAAR results show significant results for two periods: from t_{-1} to t_{+1} and from t_{+1} to t_{+2}. Both CAAR's indicate the event had a negative influence on returns (-1,444% and -2,735%, respectively). These results are in line with the AAR results but also show that the reaction was not distinctly delayed. Based on the AAR and CAAR results there was a negative reaction to the non-military event of the EU providing monetary support for Ukraine.

For the event on 3rd of May 2022 also, the CAAR results support the AAR results. The CAAR was significant for the periods from t_{-2} to t_{-1} (-1,150%) and t_{-1} to t_{+1} (-1,307%). The change is greater closer to the event date but still the reaction appears to be anticipated to some extent since the reaction was most considerable the day before the event. Nevertheless, the results suggest that the event when Putin threatened the West of retaliatory sanctions adversely affected the returns.

Non-Military events

Event day	[t1,t2]	CAAR	J1
23.3.2022	[-2,-1]	-0,581 %	-0,835
	[-1,+1]	-1,444 %	-2,937***
	[0,0]	0,348 %	0,707
	[0,+1]	-0,849 %	-1,220
	[+1,+2]	-2,735 %	-3,933***
3.5.2022	[-2,-1]	-1,150 %	-1,620*
	[-1,+1]	-1,307 %	-2,603***
	[0,0]	-0,262 %	-0,521
	[0,+1]	0,207 %	0,292
	[+1,+2]	0,264 %	0,371
5.9.2022	[-2,-1]	-0,220 %	-0,325
	[-1,+1]	-0,615 %	-1,288*
	[0,0]	-1,100 %	-2,303**
	[0,+1]	-0,905 %	-1,339*
	[+1,+2]	-0,173 %	-0,256
21.9.2022	[-2,-1]	-0,139 %	-0,205
	[-1,+1]	-1,625 %	-3,388***
	[0,0]	-0,805 %	-1,679**
	[0,+1]	-1,392 %	-2,052**
	[+1,+2]	-0,256 %	-0,377
17.10.2022	[-2,-1]	0,599 %	0,914
	[-1,+1]	0,272 %	0,587
	[0,0]	0,001 %	0,002
	[0,+1]	0,787 %	1,203
	[+1,+2]	1,873 %	2,862***
21.12.2022	[-2,-1]	-2,492 %	-3,855***
	[-1,+1]	0,342 %	0,749
	[0,0]	1,075 %	2,352***
	[0,+1]	1,756 %	2,717***
	[+1,+2]	0,554 %	0,857
25.1.2023	[-2,-1]	-0,552 %	-0,848
	[-1,+1]	-0,006 %	-0,014
	[0,0]	0,284 %	0,617
	[0,+1]	0,105 %	0,162
	[+1,+2]	1,068 %	1,640*
20.2.2023	[-2,-1]	0,148 %	0,229
	[-1,+1]	-1,321 %	-2,889***
	[0,0]	-0,987 %	-2,158**
	[0,+1]	-1,211 %	-1,872**
	[+1,+2]	-0,682 %	-1,055

* p<=0.1; ** p<=0.05; *** p<=0.01

Table 7. Cumulative average abnormal returns (CAAR) of the non-military events.

Similarly, for the event on 5th of September 2022 the CAAR results support the AAR results. In addition to the return on the event date, the CAAR was significant and negative for time windows around the event day; -0,615% from t_{-1} to t_{+1} and -0,905% from t_0 to t_{+1}. As the greatest adverse effect occurred at t_0 (-1,100%) it indicates the event date impacted the returns most. Altogether the results indicate there was a negative reaction to the non-military event when Russia halted gas supply to Europe and the influence was most considerable on the event day.

According to the AAR results of the event on 21st of September 2022 there was no significant reaction on any individual day, however the CAAR results does indicate a reaction during the event window. The CAAR was significant for three different time periods: from t_{-1} to t_{+1} (-1,625%), from t_0 to t_0 (-0,805%) and from t_0 to t_{+1} (-1,392%) which indicates the reaction occurred close to the event date. Also, these results were significant at 1% and 5% levels. Even though the AAR results did not indicate a reaction, the CAAR results still suggest the event when Putin made an announcement of partial mobilization and threatened nuclear retaliation did influence the returns negatively.

According to the CAAR results there was a significant reaction only in the post-event window of the event on 17th of October 2022. Table 7 shows the CAAR was significant (at 1% level) with 1,873% only from t_{+1} to t_{+2} even though the AAR results showed significant (at 5% level) changes at t_{-2} and at t_{+2}. According to the CAAR results there was not a considerable influence of the event on returns during the pre-event window. Nevertheless, both results suggest there was a reaction to the event when the United States announced to provide long-range missiles to support Ukraine and the influence on returns was positive.

For the event on 21st of December 2022 the CAAR was significant in the pre-event window (from t_{-2} to t_{-1}) and resulted negative (-2,492%) but then changed to positive on the event date (1,075%) and after (1,756% from t_0 to t_{+1}). The results combined indicate of a higher volatility during the event window since the AAR and CAAR are negative in the pre-event window and positive on the event day and the day following. Since both results changed to positive on the day of the event, the results suggest there was a positive reaction to the Ukrainian president's visit to the White House. Additionally, as the AAR was highest on the event day the markets appear to have reacted immediately to the event.

The CAAR results of the event on 25th of January 2023 are equivalent to the AAR results as the only significant CAAR can be observed in the post-event window (from t_{+1} to t_{+2}) and indicate of a positive influence (1,068%) on returns. The AAR was significant at 5% level and the CAAR at 10% level. Based on the results volatility was higher during the time near the event since the AAR varied from negative to positive between different dates. Overall, the announcement of Germany and the United States providing military vehicle to support Ukraine did positively influence the returns although the reaction to the event was delayed.

Lastly, the CAAR results show a significant reaction to the event on 20th of February 2023. In addition to the change on the day of the event, the CAAR was significant from t_{-1} to t_{+1} (-1,321%) and from t_0 to t_{+1} (-1,211%). Since the AAR was significant on the event date and the CAAR's near the event date, the results indicate the reaction to the event occurred immediately. Based on the results, there was a negative reaction to the event when the president of the United States visited Kyiv.

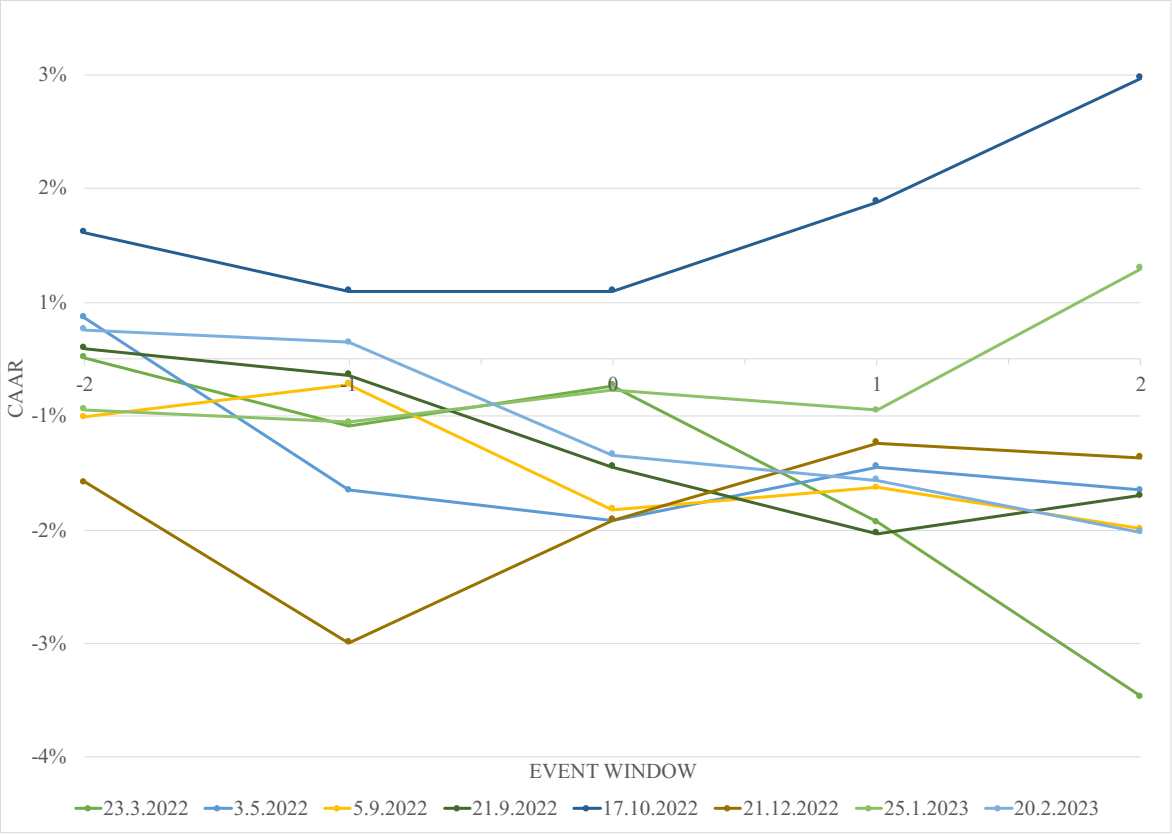


Figure 4. Cumulative average abnormal returns of the non-military events through the event window.

In Figure 4 the cumulative average abnormal returns are illustrated for each day within the event windows for the non-military events. As can be seen, the positive impact was most substantial after the event on 17th of October 2022. The figure also shows, the event on 23rd of February 2022 was the non-military event to have the most severe adverse effect on the returns. Overall, the impact of the non-military events on returns was more often negative compared to the military events since the CAAR through the event window was positive only for two non-military events.

5.3 Comparison of the event types

To understand and clarify the impact of different event types on returns, averages of the results of all events by event types were calculated. These results are presented in Table 8. As can be seen from the results, on average the military events had a positive effect on the returns whereas for non-military events on average the impact was negative.

	Military events		**Non-military events**	
Event window	**AAR**	**t-value**	**AAR**	**t-value**
-2	0,365 %	0,742	-0,023 %	-0,048
-1	0,068 %	0,138	-0,526 %	-1,110
0	0,379 %	0,769	-0,181 %	-0,382
1	-0,024 %	-0,049	-0,007 %	-0,014
2	0,343 %	0,696	-0,004 %	-0,009
Event window	**CAAR**	**J1**	**CAAR**	**J1**
[-2,-1]	0,433 %	0,440	-0,548 %	-0,579
[-1,+1]	0,422 %	0,606	-0,713 %	-1,064
[0,0]	0,379 %	0,544	-0,181 %	-0,270
[0,+1]	0,354 %	0,360	-0,188 %	-0,198
[+1,+2]	0,318 %	0,323	-0,011 %	-0,011

* p<=0.1; ** p<=0.05; *** p<=0.01

Table 8. Average AAR and CAAR of all events by event type.

The average AAR was positive (0,379%) for the military events and negative (-0,181%) for the non-military events on the event day (t_0). Thus, according to the results, the military events had on average a positive and larger impact on returns on the day of the event, while the non-military events had on average a negative and smaller impact on returns. Furthermore, all average CAAR results were positive for the military events and negative for the non-military events, regardless of the time period on which the averages of the average abnormal returns were cumulated.

Based on the AAR results, the most substantial effect on returns of a single day was on average the event day (0,379% at t_0) for the military events and the preceding day (-0,526% at t_{-1}) for the non-military events. However, regarding the military events the CAAR results suggest that on average the impact (0,433%) would have been most considerable in the pre-event window (from t_{-2} to t_{-1}) compared to the event date. Considering the non-military events, on average the most substantial influence (-0,713%) on returns would have had the days close to the event date (from t_{-1} to t_{+1}).

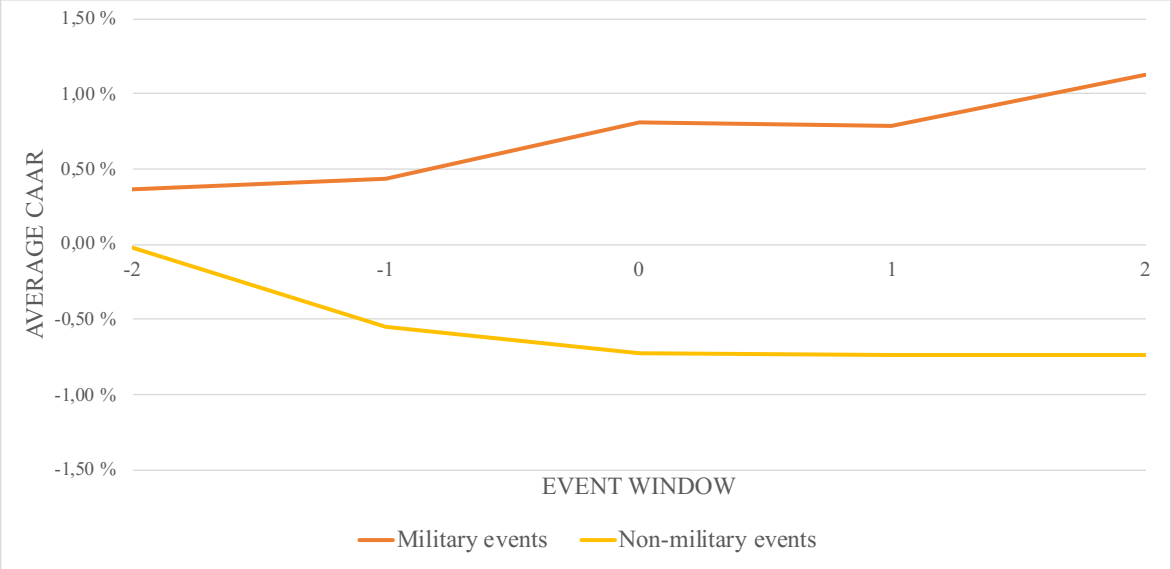


Figure 5. Average CAAR by event types.

However, all average AAR and average CAAR results were found to be statistically non-significant. Hence, these results imply that on average the returns were positive on the day of the military events, but the average reaction was not significant. Conversely, the results

suggest that on average on the day of the non-military events the returns were negative, but the average reaction was non-significant as well. The average CAAR's during the event windows are illustrated in Figure 5 which shows the average development of both event types. Also, it can be seen from the figure that on average the impact of the military events within the whole event window was greater than of the non-military events.

5.4 Long-term performance

The cumulative returns of the defined time periods for each company within the research are presented in Table 9 in which the returns are presented in percentages. As the results show, most of the stocks experienced negative cumulative returns in the first month after the last event included in the study. The negative cumulative return was most substantial for Digitalist (-14,25%). Only the stocks of Nokia (2,80%), Bittium (2,47%) and Kone (0,99%) had slightly positive cumulative returns during this time frame. The 1-month negative cumulative returns imply the technology industry companies might have still been adversely affected by the war.

The 3-month cumulative return results appeared more dispersed as the direction of the returns reversed for some of the stocks while for others the negative course deepened. For instance, the negative path continued for the stock of Digitalist resulting again the greatest negative cumulative return (-21,59%) during the three-month period. Additionally, considerable drops in cumulative returns occurred for the stocks of Fiskars (-16,96%), Tecnotree (-16,16%), Nokia (-13,55%), Tietoevry (-12,99%), Gofore (-11,60%), and Valmet (-11,33%). The results imply these companies did not manage to recover over the three-month period and were still negatively affected by the war. Interestingly, for Wärtsilä the course of the cumulative return shifted notably from 1-month (-4,26%) to 3-months (15,61%) contrarily suggesting the company was able to recover during the three-month period after the latest event. Similar change can be observed for Konceranes as the cumulative return increased from -1,14% to 10,40%.

However, the results of the 6-month cumulative returns appear negative for most of the technology industry companies. Again, Digitalist experienced the greatest negative cumulative return (-26,49%) but considerable negative developments could be observed for Valmet (-25,06%), Tietoevry (-24,18%) and Gofore (-21,16%) as well. Noticeably, the

course of Konecranes' stock changed again as the 6-mont cumulative return was -0,12%. Conversely, Fiskars managed to change the course to positive direction as the 6-month cumulative return appeared positive with 4,33%. Also, again the 6-month cumulative return was highest for Wärtsilä (27,15%).

	1M		3M		6M		1Y	
	cumulative return	t-test	cumulative return	t-test	cumulative return	t-test	cumulative return	t-test
BITTIUM	2,47	0,78	-1,47	0,69	-5,32	0,37	6,88	0,58
CARGOTEC	-4,69	-0,16	4,68	0,91	-9,48	0,16	27,67	1,39
DIGIA	-1,55	0,26	6,08	1,06	-1,27	0,55	-10,07	0,06
DIGITALIST	-14,25	-0,93	-21,59	-0,84	-26,49	-0,86	-42,77	-1,38
FISKARS	-3,75	-0,07	-16,96	-0,81	4,33	0,96	-1,05	0,45
GOFORE	-5,04	-0,26	-11,60	-0,24	-21,16	-0,61	-17,70	-0,30
INNOFACTOR	-4,59	-0,21	-2,16	0,52	-5,78	0,33	8,23	0,71
KONE	0,99	1,01	-0,57	0,96	-12,54	-0,14	-7,05	0,20
KONECRANES	-1,14	0,32	10,40	1,23	-0,12	0,65	46,83	2,00*
METSO	-1,10	0,38	0,14	0,82	3,04	0,98	-4,55	0,35
NOKIA	2,80	1,37	-13,55	-0,44	-16,03	-0,33	-26,19	-0,74
TECNOTREE	-2,47	0,12	-16,16	-0,25	-9,53	0,17	-44,83	-1,03
TIETOEVRY	-1,44	0,59	-12,99	-0,44	-24,18	-0,99	-25,88	-0,97
VAISALA	-2,33	0,10	4,84	0,93	-12,21	-0,01	-12,30	-0,02
VALMET	-2,77	0,17	-11,33	-0,14	-25,06	-0,94	-21,60	-0,57
WÄRTSILÄ	-4,26	-0,11	15,61	1,61	27,15	2,01*	53,22	2,11*
OMXH25	-3,19		-8,56		-10,38		-8,86	

*5% significance level

Table 9. Cumulative returns.

When looking at the 1-year cumulative returns it is noticeable that for only five stocks out of 16 the outcome was positive and for several stocks with a negative development the drop was considerable. For instance, for Tecnotree, Digitalist, Nokia, Tietoevry, Valmet and Nokia the cumulative return were -44,83%, -42,77%, -26,19%, -25,88% and 21,60% respectively. On the contrary, the 1-year cumulative return was notably positive for Wärtsilä (53,22%), Konecranes (46,83%) and Cargotec (27,67%). However, it should be noted that of all the cumulative return results only the 1-year return of Konecranes and both the 6-month and 1-year returns of Wärtsilä are significant at 5% level.

When analysing the cumulative returns of individual companies' stocks', certain observations of the performance development through the one-year period can be made. For instance, the cumulative return of Wärtsilä was negative at 1-month but changed to positive after and proceeded to increase until the 1-year mark. Also, the company obtained the highest 1-year cumulative return of all companies. The results suggest that after the latest event the effects of the war affected the stock of Wärtsilä over the one-month period after which the company managed to recover from the implications of the war. The development of the cumulative return of Konecranes' stock was more volatile during the first six months after the latest event but after the six-month mark the course shifted significantly. Similar pattern is observable for the stock of Cargotec although the 1-year cumulative return appears lower. These results suggest the implications of the war persisted longer but ultimately the companies managed to recover.

Based on the 1-year cumulative returns of the stocks, several companies failed to recover from the effects of the war within the year after the latest war event. The most noticeable of these companies based on the results were Tecnotree and Digitalist. However, as the cumulative return of the OMXH25 index was negative for every period examined, a part of the decrease in returns could be explained by the general market conditions. For instance, the 1-year cumulative returns for Fiskars, Metso and Kone were negative, but the excess returns resulted positive 7,81%, 4,31% and 1,81%, respectively. Thus, other causes could have contributed to the negative cumulative returns. The excess cumulative returns of each stock for the four time periods are presented in Table 10 where all numbers are in percentages.

According to the excess returns, the negative development was most considerable for Tecnotree and Digitalist. Therefore, even if the effect of the general market conditions is considered the results indicate the companies failed to recover from the implications of the war. As the excess returns of Gofore, Nokia, Tietoevry and Valmet were mainly negative as well, the results suggest the implications of the war contributed to the adverse price performance of these stocks.

According to the cumulative returns the stock of Innofactor was affected by the war during the first six months after the latest event and only after this managed to recover as only the 1-year cumulative return was positive (8,23%). However, the excess returns show that the course of the stock development changed already at 3-month mark and continued to be

positive after this. Thus, when excluding the effects of the general market conditions the results imply that the company managed to recover from the implications of the war faster. Also, for the Bittium stock each excess return was positive indicating that part of the unfavourable stock price performance was due to the market conditions and not only due to the effects of the war.

	1M	3M	6M	1Y
BITTIUM	5,67	7,09	5,06	15,74
CARGOTEC	-1,50	13,24	0,90	36,53
DIGIA	1,65	14,64	9,11	-1,21
DIGITALIST	-11,06	-13,03	-16,11	-33,90
FISKARS	-0,56	-8,40	14,71	7,81
GOFORE	-1,84	-3,04	-10,78	-8,84
INNOFACTOR	-1,39	6,40	4,60	17,09
KONE	4,18	7,99	-2,15	1,81
KONECRANES	2,05	18,95	10,26	55,69
METSO	2,09	8,70	13,42	4,31
NOKIA	5,99	-4,99	-5,65	-17,32
TECNOTREE	0,72	-7,60	0,85	-35,97
TIETOEVRY	1,76	-4,44	-13,80	-17,02
VAISALA	0,86	13,40	-1,83	-3,44
VALMET	0,43	-2,78	-14,68	-12,73
WÄRTSILÄ	-1,06	24,17	37,53	62,08

Table 10. The excess cumulative returns.

Intriguing observations can also be made of the excess returns of the companies in different sectors within the technology industry. From the eight companies for which the 1-year excess cumulative return was negative, five were in the information technology sector. The development of the excess cumulative returns for these companies was negative through most of the one-year period. Also, for only one company in the information technology sector the result was positive. Conversely, from the eight companies for which the 1-year excess cumulative return was positive, six were in the machine and metal industry sector. For these companies the development of the returns was mainly positive over the whole

period, or the trend turned either after 1-month or 3-month points. Additionally, the return was negative for only one company within the machine and metal industry sector. No clear pattern was perceived for the companies within the electronics and electrical industry.

Figure 6 and Figure 7 illustrates the cumulative returns of each stock during the one-year period after the latest war event assuming an investor would have invested one euro to each stock at the beginning of the period. The first graph differentiates the stocks that outperformed the market and the second one those that underperformed. Generally, it can be observed from both figures that the cumulative returns are more parallel at the beginning of the one-year period while towards the end the returns are more scattered.

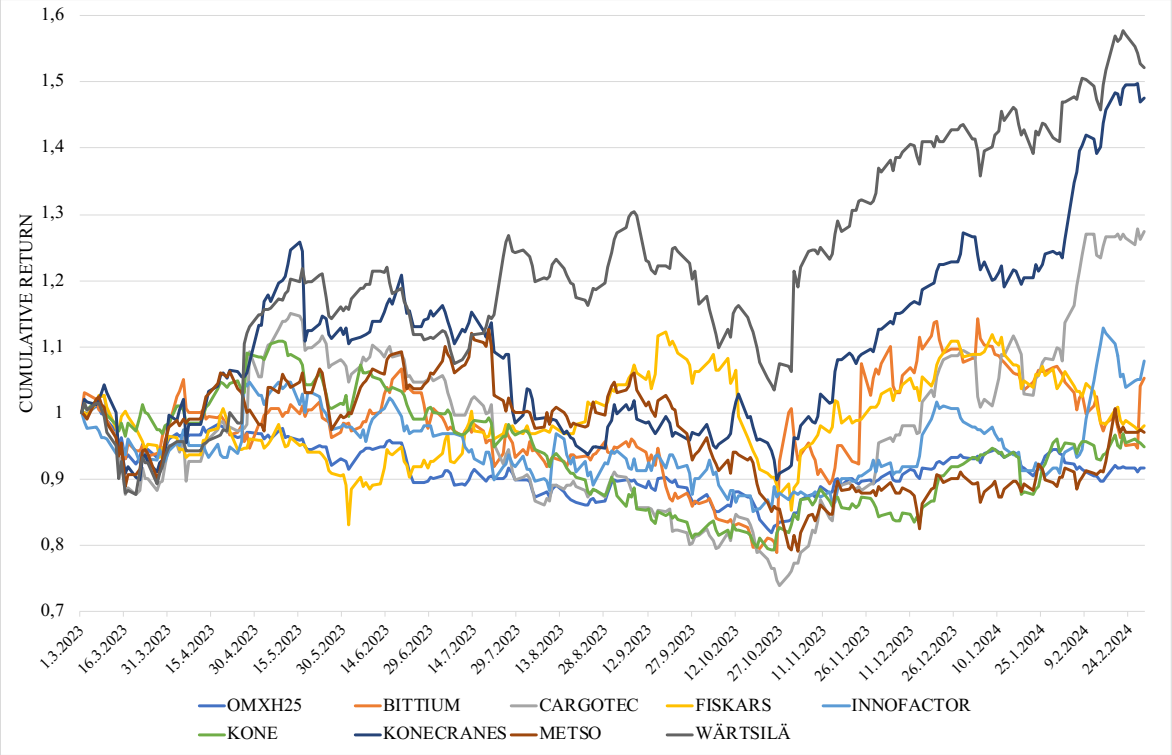


Figure 6. Cumulative returns of companies which outperformed the market.

Additionally, Figure 6 shows distinctly the superiority of the stocks of Wärtsilä and Konecranes compared to other stocks at the end of the period. Also, the relatively favourable performance of the Cargotec's stock can be observed from the graph. Even though the graph shows the stocks which outperformed the market, still the stocks of Fiskars, Metso, and Kone resulted negative cumulative returns. Hence, of all the stocks within the study only Wärtsilä,

Konecranes, Cargotec, Innofactor and Bittium reached positive cumulative returns at the end of the one-year period.

Figure 7 shows distinctly the most considerable negative development of the Tecnotree stock. A substantial increase in returns can be observed for the stock at the beginning of the period. However, a lot of volatility occurs ultimately leading to greatest negative cumulative return. Also, the downward trend of the Digitalist stock is visible from the figure. Additionally, the stock of Digia performed better than the market for the most part of the period though eventually the 1-year cumulative return remained lower.

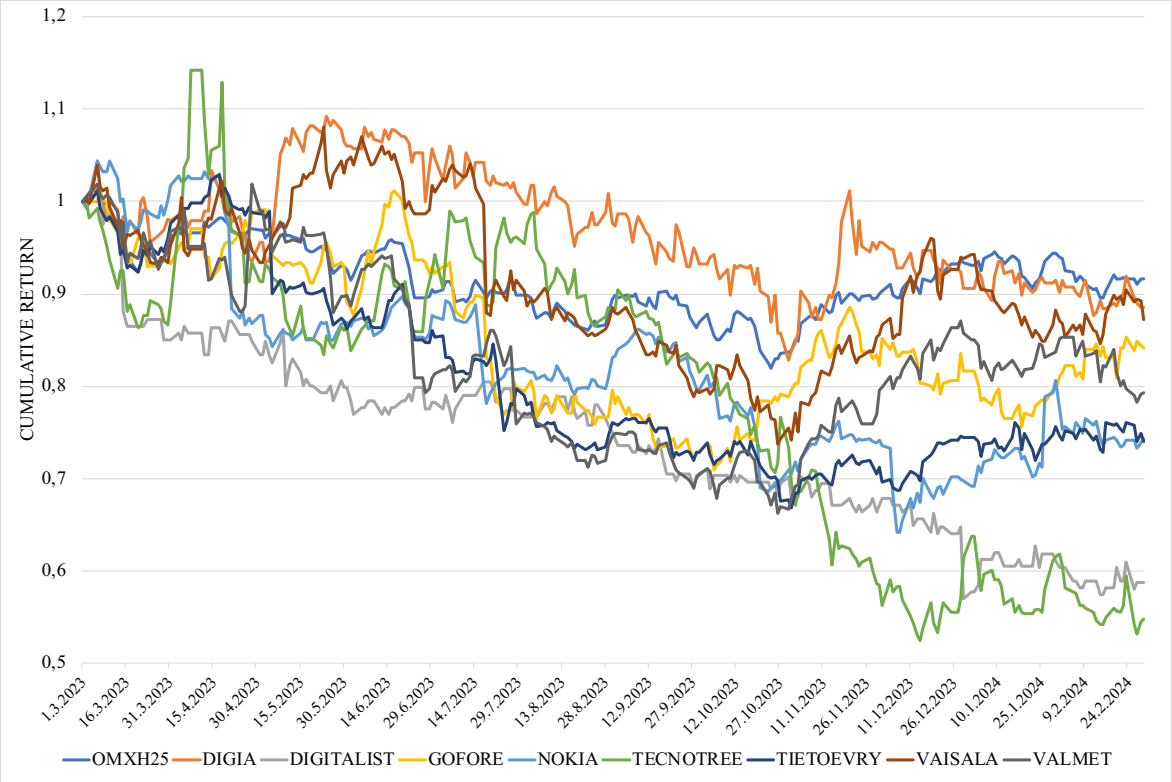


Figure 7. Cumulative returns of companies which underperformed the market.

Lastly, the average cumulative return of the technology industry was compared to the cumulative return of the market during the one-year period after the latest event. This comparison is illustrated in Figure 8. The technology industry average represents the average of the daily cumulative returns of all the stocks within the study and OMXH25 reflects the market.

At the beginning of the one-year period the average cumulative return of the technology industry appears to change in accordance with the index. Also, there is a distinct drop in cumulative returns in the first month after the latest event. After few months the technology industry manages to outperform the market until the end of the six months period. Another noticeable drop occurs in October after which the cumulative returns change to an upward trend. For most of the one-year review period the technology sector performed better than the market index and ultimately managed to outperform the market at the end.

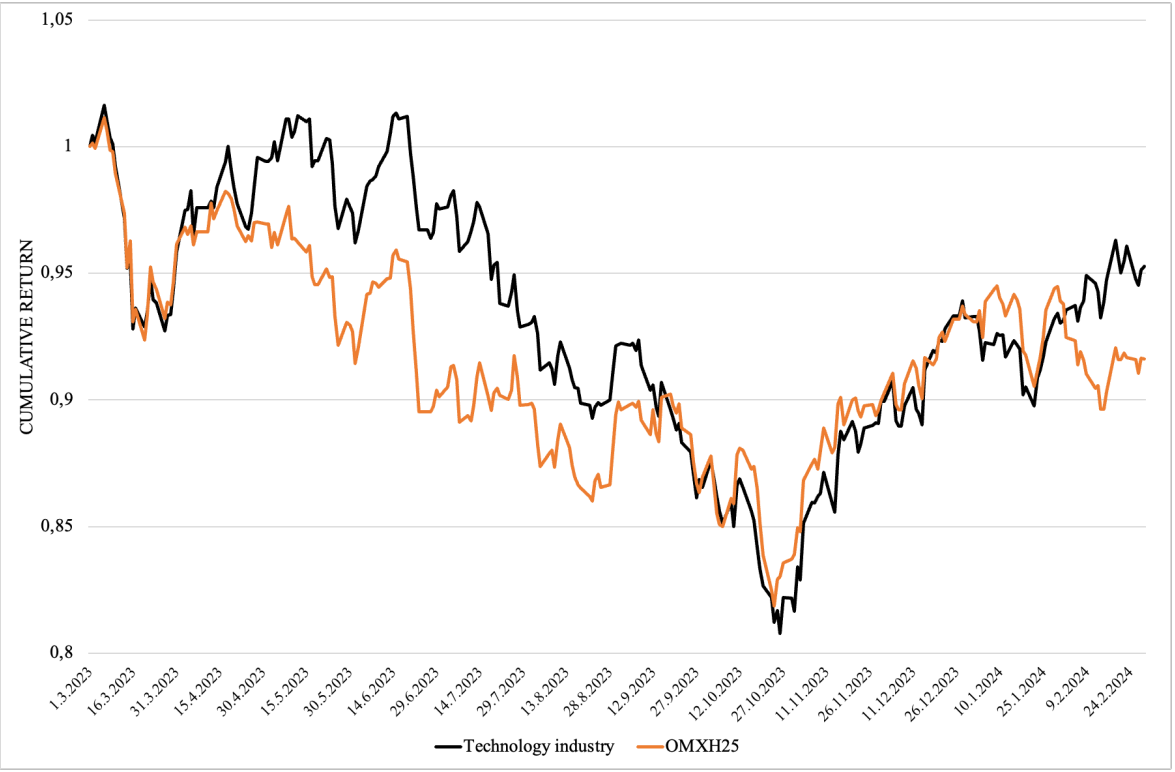


Figure 8. Average cumulative return of technology industry compared to the market.

Despite the implications of the war for the technology industry, on average the performance was superior compared to the market. However, the general trend of both cumulative returns for the whole period is downward and the 1-year cumulative returns appear negative. Eventually, as the 1-year average cumulative return of the technology industry was negative it may indicate that the sector was not able to completely recover from the implications of the war within the year.

5.5 Discussion

In general, the results of this study show that different events related to the Russia-Ukraine war have had an impact on the stock performance of the Finnish technology industry companies. Although a market reaction was not observed for all events selected in this study, they were identified for both types of events. In addition, the events had both positive and negative impacts on the stock returns regardless of the event type. Correspondingly, Choudhry (2009) found that both military and non-military events can cause stock price movements and suggested that rather the market's interpretation of the character of the news is to affect the direction of the reaction.

According to the results, there were five events in total which had a significant impact on returns precisely on the event day. From these events, two were military (24th of February 2022 and 14th of April 2022) and three were non-military (5th of September 2022, 21st of December 2022 and 20th of February 2023). In general, this indicates that the investors of the Finnish technology industry considered these events affected the companies immediately. Also, Fama (1970) suggested that information should be reflected in asset prices without delay for the markets to be efficient. Thus, based on the results the market appears to have been efficient at the time of these events.

When examining the first military event when Russia attacked Ukraine on 24th of February 2022, i.e., the war broke out, the results show that the effect on returns was positive. This indicates the investors of the Finnish technology industry considered the beginning of the war positively affected these companies. However, other research have shown the negative effects of the outbreak of the war on stock markets have been extensive, and especially those countries that share border with Russia, as well as Europe in general, or countries that have important trade relations with Russia, were most adversely affected (e.g. Boubaker et al., 2023; Boungou & Yatié, 2022 and Yousaf et al., 2022). Although the trade relationship with Russia has been significant for Finland, and especially for the Finnish technology sector, according to the results, this was not reflected in the investor reaction similarly as in other European countries or Russia's border neighbours. This is similar to the results of Ahmed et al. (2022) which showed that the technology sector's stocks in Europe generally were not adversely affected by the start of the war on the event day, but the influence was positive only after the event day. Nevertheless, this finding adds to the understanding of the effects

of the war for Finland since, unlike in Europe more broadly, the outbreak of the war had an immediate impact on the Finnish technology industry stocks which may possibly be due to the industry's specific importance on the country's overall economy. Also, since the reaction was positive, the results show that regardless of the geographical location or trade relations, investors' decision-making was more influenced by other factors. Schneider & Troeger (2006) argued that the direction of the market reaction is mostly connected to the predictability of a war event. Since there were indications of a possible war, the event may have been expected to realise. On the other hand, the positive market reaction may be explained, for instance, by the fact that the implications of the war on the technology industry have not necessarily been recognized by the investors at this point.

Regarding the event on 14th of April 2022, when Ukraine hit the Russian missile cruiser Moskva, the results indicate investors would have interpreted this military event to affect the performance of the Finnish technology industry companies positively. Choudhry (2009) suggested that if news are interpreted as positive share prices often increase and contrarily, they decrease if the interpretation is negative. Thus, victories would be reflected positively in asset prices whereas prolongation of the war would lead to an opposite development. Frey and Kucher (2001) also demonstrated that the interpretation of a war event is usually reflected in the direction of the asset price movement. Based on this, the event in April may have appeared to the investors as a Ukrainian victory or possibly even as an indication to an ending of the conflict and therefore, was reflected in the stock performance positively.

Correspondingly, the investors may have considered other countries' showing support or giving aid to Ukraine as positive. For instance, the market reaction was also positive to the non-military event on 21st of December 2022, when the Ukrainian president visited the White House, suggesting the news was positive for the investors. Consequently, the event was reflected accordingly in the returns and the direction of the share price movements of the Finnish technology industry companies.

On the contrary, the market reaction was negative to the non-military event on 5th of September 2022, when Russia halted gas supply to Europe. According to Pástor and Veronesi (2012) and Li et al. (2024) an increase in political risk decreases stock prices. Because the event concerned Russia's counteractions against sanctions imposed by other countries, investors may have seen the event to increase political risk in Finland, as well as

in Europe in general. Thus, the increased uncertainty may have caused the share prices of the technology industry companies to decrease.

Then, the results indicated the market reaction to the event on 20th of February 2023, when the US president visited Kyiv, was negative. This development is the opposite to the impact of the event in December, even though it involves a similar act of support for Ukraine by another country. Because the war had continued for a year at this point, the investors may have interpreted the event would not help to find a solution to end the war and therefore the reaction to the event was not positive either. It is also possible that other event, related or un-related to the war, may have influenced investors' decision making.

Although no immediate reactions were identified for the other events, the results suggested that some of them did also influence investor behaviour and hence, the returns. Based on the results, the market reaction was distinctly anticipated regarding the military event on 2nd of March 2022 and the non-military event on 3rd of May 2022. Conversely, the reaction appeared distinctly delayed in case of the non-military event on 25th of January 2023. Furthermore, for multiple events the days surrounding the event date influenced the returns and consequently the impact on the market was noticeable. This could imply that the markets were not efficient at the time. However, according to Wells (2004) cumulative abnormal returns are advantageous if specifying an exact event date is problematic. Even if the dates of the events are known, news were often published over several days and the information might have reached investors at different times. Also, the publication of news might have been dispersed over several days near the event day and therefore the investors did not react significantly based on one day only. For instance, in case of the anticipated reactions the results would suggest news indicative of the event were available earlier. Alternatively, results of delayed reactions could indicate that investors received more information over the days. Furthermore, regarding the military event on 9th of November 2022, when Russian forces were forced to withdraw from Kherson, the impact intensified over the days which may also indicate that more information was received later. Overall, the CAAR results suggested that these other events also impacted the stock performance even though the market reaction was not immediate.

As discussed, regarding the military event on 16th of March 2022 the only significant results were the AAR at t_{-2} and the CAAR from t_{-2} to t_{-1}. Also, both results were significant only at 10% level. Since there were no other significant abnormal returns found and the abnormal

return on the event date conversely resulted slightly positive, the results do not imply the event would have had a considerable impact on the stock performance. Similarly, the influence of the military event on 16th of May 2022 did not appear substantial as there were no significant AAR results and only the CAAR from t_{-1} to t_{+1} resulted significant. Concerning the military event on 10th of October 2022 there were also two significant results, the positive AAR two days before the event and the positive CAAR from t_{-2} to t_{-1}. Even though these were significant at 1% level, since all the following abnormal returns were negative and non-significant in the event window, it cannot be concluded that the event had a significant influence on the stock performance. Hence, the null hypothesis could not be rejected for the military events that occurred on 16th of March 2022, 16th of May 2022 and 10th of October 2022. Thus, according to the results, the investors of the Finnish technology industry companies supposed these events did not significantly impact the performance of the companies.

All other events were found to have influenced the stock performance significantly. Based on this, the events which were found to have impacted the abnormal stock performance are presented in Table 11. Those events which caused an immediate market reaction on the day of the event are marked with an asterisk. Also, the influences of the events on the stocks are gathered in the said table.

Table 11 shows that regardless of the type of the event, an event may have influenced the abnormal stock performance positively or negatively. The attack on 9th of March 2022 had a negative impact which could be due to the possibility that the Russian attack may have been seen as an indication of continuation of the war and that a solution to the situation would not be found soon. Contrarily, the positive influences of the military events on 14th of April 2022 and 9th of November 2022 may have been seen as victories for Ukraine and possibly as indications of ending the war. Furthermore, these results show the threats of Russia had negative influences on the stock performance (3rd of May 2022, 5th of September 2022 and 21st of September 2022). The investors may have interpreted these events to indicate continuation of the war despite the measures taken to pressure Russia to end its incursion. Also, these events may have increased political risk and general uncertainty influencing investor behaviour. Moreover, the table shows that in most cases the efforts to provide support for Ukraine were seen as positive (17th of October 2022, 21st of December

2022 and 25th of January 2023). These events may have been interpreted as actions supporting Ukraine's position and thereby as contributions to end the war.

Event date	Event	Influence
Military events		
24.2.2022*	Russia invades Ukraine and attacks Kyiv and Kharkiv	positive
2.3.2022	Russia seizes the Ukrainian city Kherson and the Zaporizhzhia nuclear plant	positive
9.3.2022	Russia attacks the Mariupol maternity hospital	negative
14.4.2022*	Ukraine has hit the Russian missile cruiser Moskva causing the ship to sink	positive
9.11.2022	Russian forces are forced to withdraw from Kherson	positive
Non-military events		
23.3.2022	EU approves additional support package to Ukraine	negative
3.5.2022	Putin threatens retaliatory sanctions to the West	negative
5.9.2022*	Russia halts gas supply to Europe	negative
21.9.2022	Putin announces partial mobilization and threatens nuclear retaliation	negative
17.10.2022	The United States provides long-range missiles to support Ukraine	positive
21.12.2022*	Ukrainian president Volodymyr Zelenskyi visits the White House	positive
25.1.2023	The United States and Germany announce to send tanks to support Ukraine	positive
20.2.2023*	The US president Joe Biden visits Kyiv	negative

Table 11. The events which influenced the abnormal stock performance.

However, the influence of the events on 2nd of March 2022 and 23rd of March 2022 were contrary to the above. Regarding the event on 2nd of March 2022, when Russia seized Kherson and the Zaporizhzhia nuclear plant, the influence was positive even though it considered Russian progress. Like the initial invasion, the event may have been expected to realise since there were numerous events in the early days of the war and a lot of news were published. Alternatively, again similar to the initial invasion, the implications of the war on the technology industry might not have been completely recognized yet.

Furthermore, the influence of the event on 23rd of March 2022, when EU approved additional support package to Ukraine, could be explained by the increased political risk. Generally, for several events increased volatility can be observed in the results during the event windows as the direction of the abnormal returns changed between different dates. Since an increase in political risk is known to increase the volatility of the stock market (Kim & Mei,

2001) the events might have induced fluctuations in the stock prices of the Finnish technology industry companies. Investors may have interpreted those events to also increase political risk in Finland and thus increasing volatility in the Finnish stock market. The uncertainty associated to the situation may have increased the experience of increased political risk and therefore, could explain why some countermeasures against Russia was reflected negatively in the stock performance. Also, the volatility of stock market would be more likely to increase if the market expects the event to realise (Schneider & Troeger, 2006). Thus, higher volatility near the event dates may also originate from dispersed publication of information.

When observing the averages of the results for both event types, the impact of military events appears more substantial. The results of both event types show that on average the investors interpreted the military events to influence positively the performance of the Finnish technology industry companies. On the contrary, on average the non-military events were interpreted to have a negative effect on the performance. However, since none of the results were found to be statistically significant, the results imply, that there were no statistically significant differences between the different event types in terms of their impact on investors' decision-making.

The long-term performance analysis shows the long-term effects on stocks differed between the technology industry companies, and suggest some companies managed to recover from the implications of the war faster than others. Overall, the results show that during the one-year period after the latest event, majority of the companies suffered negative cumulative returns and only for third of the companies the returns were positive. The results show that especially during the first six months a lot of volatility in the returns was experienced and for only one company the returns changed to an ascending trend after the first month. For one fourth of the companies, there was a downward trend in the cumulative stock returns throughout the entire year.

However, the negative development of the index during the same period implies the general market conditions may have contributed to the outcome. After excluding the market return, the excess cumulative returns for the one-year period were positive for half of the companies. Also, the positive development of the returns was then visible for several stocks already during the first six months of the one-year period. According to Li et al. (2024) political risk adversely affects stock prices. Correspondingly, the uncertainty caused by the state of

political risk in Finland may have contributed to the development of the overall market since the Russia-Ukraine war continued to unfold. Thus, part of the unfavourable development may have been due to the effect of political risk on overall market and not just by the ability of an individual company to overcome the challenges caused by the war. Nevertheless, the significantly better performance of some of the companies suggest the individual efforts did contribute to the outcome.

The comparison between different sectors within the technology industry shows the adverse effects of the war on the long-term performance concerned most the information technology sector. On the contrary, the machine and metal industry sector appeared to recover most successfully. The divergence between sectors could be due to, for instance, differences in the significance of Russian ties in the industry or the availability of alternative markets. Thus, the comparison suggests that in addition to the individual companies' efforts, the sector-specific differences have also influenced how the implications of the war were reflected on the long-term performance.

As a significant part of the imposed sanctions has been targeted to the technology industry, the war has challenged many companies within the sector. Companies whose business has included trading with Russia have been obliged to look for new markets for their products and services. (Bank of Finland 2022) Thus, the results suggest that the companies which did not manage to recover during the one-year period may still have struggled with the challenges provided by the restrictions on trade with Russia. Therefore, investor confidence in such companies may have suffered, which in turn has been reflected in share prices.

6 Conclusions

The objective of this research was to study the impact of the Russia-Ukraine conflict on the stock performance of Finnish technology industry companies. The study was mainly motivated by the development of political risk in Finland following the war and its effects on the country's stock market, as well as previous research evidencing that the severity of the stock market's reaction to the war has been related to geographical location and the importance of trade relations with Russia. The aim was to gain a broader understanding of the effects of the war on stock price performance by studying multiple war related events, both military and non-military. Furthermore, the long-term performance of the companies was analysed as the war continues to unfold to this date. Unlike previous research, the study focused on the technology industry specifically due to its significance to the overall Finnish economy. Because Russia has been a significant trading partner for the Finnish technology industry, sanctions targeted to the sector were likely to adversely affect the Finnish companies in the industry. This chapter summarizes the research results and provides answers to the research questions. Some ideas for future research are also offered and the limitations of the research are discussed.

6.1 Summary

The study focused on 16 publicly traded companies operating within the different business lines of the Finnish technology industry and the effects of the war were examined by using the daily total return index prices. The first research question was:

"How did the events of the Russia-Ukraine conflict impact the abnormal stock performance of Finnish technology industry companies?"

To analyse the impacts of the war events on the stock performance of Finnish technology industry companies, 16 different events were researched by using the event study methodology. The selection of events provided a challenge as the overlapping issue wanted

to be avoided. The results of the study showed that there were five events for which a market reaction was experienced on the day of the event, two military and three non-military events. According to the results, these events had an immediate impact on the abnormal stock performance. When the days surrounding the individual events were considered, more events in both event types were found to have influenced the abnormal stock performance. This suggests the publication of information may have been dispersed and hence reached investors at different times or the influence was amplified over the days possibly due to the development of political risk near the events.

The basic assumption in event studies is that the event does not have an impact on stock returns. Furthermore, as several events were under research the study followed this assumption. Thus, the following hypothesis was set:

H_1: The events of the Russia-Ukraine war did not have an impact on the performance of the Finnish technology industry companies.

For three military events the null hypothesis was not rejected as no considerable market reactions could be observed. To conclude, these events were not found to have had a significant impact on the stock performance of the Finnish technology industry companies. Nevertheless, for all the other events the null hypothesis was rejected. Overall, there were 13 events which evidently influenced the stock performance significantly.

To answer the first research question, it can be concluded that the events of the Russia-Ukraine war had both negative and positive impacts on the abnormal stock performance of the Finnish technology industry companies. Usually, the stock performance was influenced positively by the efforts to provide support for Ukraine whereas the threats announced by Russia affected adversely. Also, in most cases, the Ukrainian victories were interpreted as positive events and contrarily the Russian attacks as negative events. However, especially in the early days of the war, part of the events led to conflicting market reactions which may be explained by that the events were expected to realise due to the dispersed news coverage or, on the other hand, because of the increased political risk. In general, the results suggest that indications of prolongation of the war were considered as negative news whereas signs indicating that an ending to the conflict could be reached were thought to be positive news.

Additionally, the finding on the event of the primary attack of Russia on Ukraine adds to the previous research in that, unlike in Europe more broadly, the outbreak of the war had an immediate impact on technology industry stocks in Finland possibly due to the industry's specific importance on the Finnish overall economy. The event may have been expected to realise or the effects of the war on the technology industry may not have been yet entirely recognized and therefore, the outbreak of the war was reflected in a positive market reaction. Furthermore, the findings of this research complement the literature on the subject by showing that in addition to the initial invasion, other events of the war have also influenced the stock market.

To understand the influence of the events more broadly the differences between the event types was examined. Thus, the second research question was:

"Have there been differences between military and non-military events in the impact on Finnish technology industry companies' stock returns?"

The results showed that both event types have influenced the stock returns, and the events had both positive and negative impacts regardless of the event type. Also, when the average influences were compared between the event types the results showed that on average the military events had a positive impact on the stock returns and the effect was more considerable compared to the non-military events for which the effect was negative and smaller on average.

To align with the first, the following was set as the second hypothesis:

H_2: There is no statistically significant difference between the impacts of military and non-military events on the stock returns of the Finnish technology industry companies

Even though the results showed that there have been differences between military and non-military events in the average impact on Finnish technology industry companies' stock returns, the results were not statistically significant. Also, both event types were observed to

have both positive and negative effects on stock returns which indicates there is no difference between the impacts of different types of events. Therefore, the second hypothesis is not rejected. To answer the second research question, it can be concluded that non-military events typically adversely affected stock returns, but the magnitude of the impact was smaller whereas for military events the impact was positive and greater on average. However, the difference between event types is not statistically significant and, in align with the suggestion of Choudhry (2009), both military and non-military events can have an impact on the stock returns and rather the investors' interpretation of the news' character is reflected in the direction of the stock price movement.

The results of the long-term performance analysis show that only some of the companies managed to recover from the implications of the war within a year after the latest event in the study and suggest a major part still struggled with the challenges provided by the restrictions on trade with Russia. The results indicate, similar to Li et al. (2024), that since the Russia-Ukraine war continued to unfold the uncertainty caused by the state of political risk in Finland influenced the development of the overall market which has contributed to the outcome. However, there were differences between the different business lines of the technology industry on how the implications of the war influenced the long-term performance. The results showed the machine and metal industry sector managed to recover most successfully whereas the information technology sector's long-term performance was still adversely affected. To conclude, as the Finnish technology industry has been challenged by the sanctions restricting trade with Russia, the companies which did not manage to recover during the one-year period may still have struggled to find substitutive markets.

6.2 Reliability of the results

In this study, selecting the events was challenging as there have been many incidents related to the war and the war has received a lot of media coverage. Thus, the selection of events may have affected the conclusions of the study, as certain significant events had to be excluded to avoid the overlapping issue. If it would have been possible to include these events to the study, it could have affected the conclusions. Furthermore, it could not be completely ruled out that whether events which were not related to the war would have

influenced the results since the methodology cannot separate the effects of overlapping events and their impact on the results is difficult to identify.

Additionally, the methodology examines specifically the short-term impact of an event to stock prices. The Russia-Ukraine war broke out in the beginning of the year 2022 and still continues to unfold to this date. Thus, now it can be stated the war has been long-lasting. However, it was pursued to avoid this problem by applying the methodology to examine individual events and by keeping the event windows compact. Even though the individual events are part of a bigger picture, due to the analysis of the results of events individually, the results of this study can be considered mostly reliable.

Nevertheless, significant results were observed for several events which suggests the events of the Russia-Ukraine war have had an impact on the stock performance of the Finnish technology industry companies. The results of this study are not straightforwardly applicable to other markets or industries since this study focused to examine the Finnish technology industry specifically. Also, due to the characteristics of the technology industry in Finland the results are not generalizable to other countries.

6.3 Further research ideas

As the selection of events was problematic, it should be considered if another research methodology could be utilized to examine the events of the war more comprehensively. This could bring a better understanding to the topic as some significant events had to be excluded from this study. Also, another methodology could provide a better process for ensuring the issue of concurrent events does not affect the results.

In addition, previous research mainly focused on the primary invasion of Russia on Ukraine. Besides, this study focused on the impacts of the Russia-Ukraine war events specifically on the Finnish technology industry companies. It would be interesting to study how the other war related events have influenced the stock markets globally and whether this differs from the findings regarding the first attack or the findings of this study. Furthermore, the reasons of why particularly the information technology sector struggled more to recover in the long-term compared to other technology industry business lines could provide an interesting topic to research.

References

Afesorgbor, S. K. 2019. The impact of economic sanctions on international trade: How do threatened sanctions compare with imposed sanctions? European Journal of Political Economy. Vol. 56, p.1 1-26.

Ahmed, S., Hasan, M. M. and Kamal, M. R. 2022. Russia–Ukraine crisis: The effects on the European stock market. European financial management: the journal of the European Financial Management Association. Vol. 29 (4), p. 1078-1118.

Aisen, A. and Veiga, F. J. 2006. Does political instability lead to higher inflation? A panel data analysis. Journal of money, credit and banking. Vol. 38 (5), p. 1379-1389.

Aisen, A. and Veiga, F. J. 2008. Political Instability and Inflation Volatility. Public choice. Vol. 135 (3-4), p. 207-223.

Aisen, A. and Veiga, F. J. 2013. How does political instability affect economic growth? European Journal of Political Economy. Vol. 29, p.151-167.

Akin, I. and Akin, M. 2024. Behavioral finance impacts on US stock market volatility: an analysis of market anomalies. Behavioural Public Policy. P.1-25.

Alesina, A. and Perotti, R. 1996. Income distribution, political instability, and investment. European economic review. Vol. 40 (6), p.1203-1228.

Al-Thaqeb, S.A., Algharabali, B. G., Alabdulghafour, K. T. 2022. The pandemic and economic policy uncertainty. International journal of finance and economics. Vol. 27 (3), p. 2784-2794.

Armitage, S. 1995. Event study methods and evidence on their performance. Journal of economic surveys. Vol. 9 (1), p. 25-52.

Aslan, H., Easley, D., Hvidkjaer, S. and O'Hara, M. 2011. The characteristics of informed trading: Implications for asset pricing. Journal of empirical finance. Vol. 18 (5), p. 782–80.

Associated Press 2023. Key moments in a year of war after Russia invaded Ukraine. [e-publication] [referred: 8.10.2023] Available: https://apnews.com/article/russia-ukraine-war-one-year-anniversary-timeline-a1304c6fb319bf1c0e93635f6f6a2633

Autio, E. and Yli-Renko, H. 1998. New, technology-based firms in small open economies—An analysis based on the Finnish experience. Research policy. Vol.2 6 (9), p.9 73-987.

Bank of Finland 2022. Kustannuskilpailukyky tärkeä Venäjän kaupan korvaamisessa. [e-publication] [referred: 21.12.2024] Available: https://www.eurojatalous.fi/fi/2022/2/kustannuskilpailukyky-tarkea-venajan-kaupan-korvaamisessa/

Biglaiser, G. and Lektzian, D. 2020. The effects of economic sanctions on targeted countries' stock markets. International interactions. Vol. 46 (4), p. 526-550.

Binder, J. J. 1998. The Event Study Methodology since 1969. Review of quantitative finance and accounting. Vol. 11 (2), p. 111-137.

Black, F. 1972. Capital Market Equilibrium with Restricted Borrowing. The Journal of business (Chicago, Ill.). Vol. 45 (3), p. 444-455.

Black, F. 1993. Beta and Return. Journal of portfolio management. Vol. 20 (1), p. 8-18.

Bloom, N. 2009. The Impact of Uncertainty Shocks. Econometrica. Vol. 77 (3), p. 623-685.

Boubaker, S., Nguyen, N., Trinh, V. Q. and Vu, T. 2023. Market reaction to the Russian Ukrainian war: a global analysis of the banking industry. Review of accounting & finance, Vol. 22 (1), p. 123-153.

Boungou, W. and Yatié, A. 2022. The impact of the Ukraine–Russia war on world stock market returns. Economics letters. Vol. 215 (215), p. 110516.

Caldara, D. and Iacoviello, M. 2022. Measuring Geopolitical Risk. The American economic review. Vol. 112 (4), p. 1194-1225.

Campbell, J. Y., Lo, A. W. and MacKinlay, A. C. 1997. The Econometrics of Financial Markets. Princeton New Jersey, Princeton University Press.

Caporale, G. M., Gil-Alana, L. A. and Plastun, A. 2016. The Weekend Effect: An Exploitable Anomaly in the Ukrainian Stock Market? Journal of economic studies (Bradford). Vol. 43 (6), p. 954-965.

Choudhry, T. 2009. World War II events and the Dow Jones industrial index. Journal of banking & finance, Vol. 34 (5), p. 1022-1031.

CNN 2023. Russia-Ukraine war timeline. [e-publication] [referred: 7.10.2023] Available: https://edition.cnn.com/interactive/2023/02/europe/russia-ukraine-war-timeline/index.html

Crespo Cuaresma, J. and Silgoner, M. 2014. Economic Growth and Inflation in Europe: A Tale of Two Thresholds. Journal of common market studies. Vol. 52 (4), p. 843-860.

Cross, F. 1973. The Behavior of Stock Prices on Fridays and Mondays. Financial analysts journal. Vol. 29 (6), p. 67-69.

Customs 2022. EU export sanctions and Finland's trade with Russia. [e-publication] [referred: 21.12.2024] Available: https://tilastot.tulli.fi/en/-/eu-export-sanctions-and-finland-s-trade-with-russia

Darby, J., Li, C. W. and Muscatelli, V. A. 2004. Political uncertainty, public expenditure and growth. European Journal of Political Economy. Vol. 20 (1), p. 153-179.

De Bondt, W. F. M. and Thaler, R. 1985. Does the Stock Market Overreact? The Journal of Finance. Vol. 40, no. 3, p. 793–805.

De Bondt, W. F. M. and Thaler, R. 1987. Further Evidence On Investor Overreaction and Stock Market Seasonality. The Journal of finance (New York). Vol. 42 (3), p. 557-581.

De Gregorio, J. and Guidotti, P. E. 1995. Financial development and economic growth. World development. Vol. 23 (3), p. 433-448.

Devereux, M. and Wen, J. F. 1998. Political instability, capital taxation, and growth. European economic review. Vol. 42 (9), p. 1635-1651.

Diakonova, M., Ghirelli, C., Molina, L. and Pérez, J. J. 2023. The economic impact of conflict-related and policy uncertainty shocks: The case of Russia. International economics (Paris). Vol. 174, p. 69-90.

Diamonte, R., Liew, J. and Stevens, R. 1996. Political risk in emerging and developed markets. Financial analysts journal. Vol. 52 (3), p. 71-76.

Doornich, J. B. and Raspotnik, A. 2020. Economic Sanctions Disruption on International Trade Patterns and Global Trade Dynamics: Analyzing the Effects of the European Union's Sanctions on Russia. Journal of East-West business. Vol. 26 (4), p. 344-364.

Easley, D. and O'Hara, M. 2004. Information and the cost of capital. The Journal of finance (New York). Vol. 59 (4), p. 1553-1583.

Easley, D., Hvidkjaer, S. and O'Hara, M. 2002. Is information risk a determinant of asset returns. The Journal of finance (New York). Vol. 57 (5), p. 2185-2221.

Easterday, K. E., Sen, P. K. and Stephan, J. A. 2009. The Persistence of the Small Firm/January Effect: Is It Consistent with Investors' Learning and Arbitrage Efforts? The Quarterly review of economics and finance. Vol. 49 (3), p. 1172-1193.

Eaton, J. and Kortum, S. 2012. Putting Ricardo to Work. The Journal of economic perspectives. Vol. 26 (2), p. 65-89.

European Council 2023. Timeline - EU response to Russia's war of aggression against Ukraine. [e-publication] [referred: 7.10.2023] Available: https://www.consilium.europa.eu/en/policies/eu-solidarity-ukraine/timeline-russia-military-aggression-against-ukraine/

Confederation of Finnish industries 2024. Ulkomaankauppa. [e-publication] [referred: 17.12.2024] Available: https://ek.fi/tutkittua-tietoa/tietoa-suomen-taloudesta/ulkomaankauppa/

Fama, E. F. 1968. RISK, RETURN AND EQUILIBRIUM: SOME CLARIFYING COMMENTS. The Journal of finance (New York). Vol. 23 (1), p. 29-40.

Fama, E. F. 1970. Efficient Capital Markets: A Review of Theory and Empirical Work. The Journal of finance (New York). Vol. 25 (2), p. 383-417.

Fama, E. F. 1991. Efficient Capital Markets: II. The Journal of finance (New York). Vol. 46 (5), p. 1575-1617.

Fama, E. F. and French, K. R. 2004. The Capital Asset Pricing Model: Theory and Evidence. The Journal of economic perspectives. Vol. 18 (3), p. 25-46.

Flugum, R., Orlova, S., Prevost, A. and Sun, L. 2021. Distracted institutions, information asymmetry and stock price stability. Journal of business finance & accounting. Vol. 48 (9-10), p. 2015-2048.

Frankfurter, G. M. and McGoun E. G. 2001. Anomalies in Finance: What Are They and What Are They Good For? International review of financial analysis. Vol. 10 (4), p. 407-429.

Frey, B. and Kucher, M. 2001. Wars and Markets: How Bond Values Reflect the Second World War. Economica (London). Vol. 68 (271), p. 317-333.

Gala, V., Pagliardi, G. and Zenios, S. 2023. Global political risk and international stock returns. Journal of empirical finance. Vol. 72, p. 78-102.

Ghasseminejad, S. and Jahan-Parvar, M. R. 2021. The impact of financial sanctions: The case of Iran. Journal of policy modeling. Vol. 43 (3), p. 601-621.

Goel, A., Tripathi, V. and Agarwal, M. 2021. Information asymmetry and stock returns. Journal of advances in management research. Vol. 18 (1), p .85-112.

Guidolin, M., and La Ferrara, E. 2010. The Economic Effects of Violent Conflict: Evidence from Asset Market Reactions. Journal of peace research. Vol. 47 (6), p. 671-684.

Hayakawa, K., Kimura, F. and Lee, H. 2013. How Does Country Risk Matter for Foreign Direct Investment? Developing economies. Vol. 51 (1), p. 60-78.

Hudson, R. and Urquhart, A. 2015. War and stock markets: The effect of World War Two on the British stock market. International review of financial analysis. Vol. 40, p. 166-177.

Industrial Union 2022. Teollisuusliiton toimialakatsaus 2022. [e-publication] [referred: 21.12.2024] Available: https://www.teollisuusliitto.fi/liitto/tutkimustoiminta/julkaisut-ja-tutkimukset/

Industrial Union 2023. Teollisuusliiton toimialakatsaus 2023. [e-publication] [referred: 21.12.2024] Available: https://www.teollisuusliitto.fi/liitto/tutkimustoiminta/julkaisut-ja-tutkimukset/

Irvine, P., Kim, J. H. and Ren, J. 2024. The Beta Anomaly and Mutual Fund Performance. Management science. Vol. 70 (1), p. 143-163.

James, C. and Edmister, R. O. 1983. The Relation Between Common Stock Returns Trading Activity and Market Value. The Journal of finance (New York). Vol. 38 (4), p. 1075-1086.

Jawadi, F. and Pondie T. M. 2024. Political uncertainty and macro-financial dynamics in the BRICS. International economics (Paris).Vol. 179, p.100523.

Jong-A-Pin, R. 2009. On the measurement of political instability and its impact on economic growth. European Journal of Political Economy. Vol. 25 (1), p. 15-29.

Kahneman, D. and Tversky A. 1979. Prospect Theory: An Analysis of Decision under Risk. Econometrica. Vol.47 (2), p.263-291.

Kahneman, D. and Tversky A. 1992. Advances in Prospect Theory: Cumulative Representation of Uncertainty. Journal of risk and uncertainty. Vol. 5 (4), p. 297-323.

Kaitila, J. 2019. From innovation to labour costs: Change of emphasis in Finnish competitiveness policy ideas after the Eurocrisis. Competition & change. Vol. 23 (1), p. 47-70.

Keleş, E. 2023. Stock Market Response to the Russia-Ukraine War: Evidence from an Emerging Market. Journal of East-West business. Vol. 29 (3), p. 307-322.

Kim, H. and Mei, J. 2001. What makes the stock market jump? An analysis of political risk on Hong Kong stock returns. Journal of international money and finance. Vol. 20 (7), p.1003-1016.

Kirat, T. and Rezaee, A. 2019. How stock markets react to regulatory sanctions? Evidence from France. Applied economics. Vol. 51 (60), p. 6558-6566.

Knüpfer, S. and Puttonen, V. 2018. Moderni rahoitus. 10th ed. Helsinki, Alma.

Konstantakopoulou, I. 2017. The aggregate exports-GDP relation under the prism of infrequent trend breaks and multi-horizon causality. International economics and economic policy. Vol. 14 (4), p. 661-689.

Kónya, L. 2006. Exports and growth: Granger causality analysis on OECD countries with a panel data approach. Economic modelling. Vol. 23 (6), p. 978-992.

Larch, M., Shikher, S., Syropoulos, C. and Yotov, Y. V. 2022. Quantifying the impact of economic sanctions on international trade in the energy and mining sectors. Economic inquiry. Vol. 60 (3), p. 1038-1063.

Le, Q. and Zak P. J. 2006. Political risk and capital flight. Journal of international money and finance. Vol. 25 (2), p. 308-329.

Lehkonen, H. and Heimonen, K. 2015. Democracy, political risks and stock market performance. Journal of international money and finance. Vol. 59, p. 77-99.

Li, Z., Liu, Jia, Liu, Jie, Liu X. and Zhu, Y. 2024. The causal effect of political risk on the stockmarket: Evidence from a natural experiment. Australian economic papers. Vol. 63 (1), p. 145-162.

Liadze, I., Macchiarelli, C., Mortimer-Lee, P. and Sanchez Juanino, P. 2023. Economic costs of the Russia-Ukraine war. World economy. Vol. 46 (4), p. 874-886.

Liu, L., Shu, H. and Wei, K. C. 2017. The impacts of political uncertainty on asset prices: Evidence from the Bo scandal in China. Journal of financial economics. Vol. 125 (2), p. 286-310.

Lo, G. D., Marcelin, I., Bassène, T. and Sène, B. 2022. The Russo-Ukrainian war and financial markets: the role of dependence on Russian commodities. Finance research letters. Vol. 50, p. 103194.

MacKinlay, A. C. 1997. Event Studies in Economics and Finance. Journal of economic literature, Vol. 35 (1), p. 13-39.

Malkiel, B. G. 2003. The Efficient Market Hypothesis and Its Critics. The Journal of economic perspectives. Vol. 17 (1), p. 59-82.

Merkle, C. 2020. Financial Loss Aversion Illusion. Review of Finance. Vol. 24 (2), p. 381–413.

Ministry for Foreign Affairs of Finland 2023. Mitkä ovat kansainväliset pakotteet. [e-publication] [referred: 10.10.2023] Available: https://um.fi/mita-ovat-pakotteet

Morrison, C. and Schwartz A. E. 1996. The American economic review. Vol. 86 (5), p. 1095-111.

Myint, H. 1977. Adam Smith's Theory of International Trade in the Perspective of Economic Development. Economica (London). Vol. 44 (175), p. 231-248.

Nerlinger, M. and Utz, S. 2022. The impact of the Russia-Ukraine conflict on energy firms: A capital market perspective. Finance research letters. Vol. 50, p. 103243.

Obi, P., Waweru, F. and Nyangy, M. 2023. An Event Study on the Reaction of Equity and Commodity Markets to the Onset of the Russia–Ukraine Conflict. Journal of risk and financial management. Vol. 16 (5), p. 256.

Oechslin, M. 2014. Targeting autocrats: Economic sanctions and regime change. European Journal of Political Economy. Vol. 36, p. 24-40.

Oinas, P. 2005. Finland: A Success Story? European planning studies. Vol. 13 (8), p. 1227-1244.

O'Sullivan, P. 2018. The Capital Asset Pricing Model and the Efficient Markets Hypothesis: The Compelling Fairy Tale of Contemporary Financial Economics. International journal of political economy. Vol. 47 (3-4), p. 225-252.

Pape, R. A. 1998. Why Economic Sanctions Still Do Not Work. International security. Vol. 23 (1), p. 66-77.

Pástor, L. and Veronesi, P. 2012. Uncertainty about Government Policy and Stock Prices. The Journal of finance (New York). Vol. 67 (4), p. 1219-1264.

Pástor, L. and Veronesi, P. 2013. Political uncertainty and risk premia. Journal of financial economics. Vol. 110 (3), p. 520-545.

Ram, R. 1985. Exports and Economic Growth: Some Additional Evidence. Economic development and cultural change. Vol. 33 (2), p. 415-425.

Reuters 2022. Ukraine war: six months that shook the world. [e-publication] [referred: 8.10.2023] Available: https://www.reuters.com/world/europe/ukraine-war-six-months-that-shook-world-2022-08-22/

Reuters 2022. Timeline: The events leading up to Russia's invasion of Ukraine. [e-publication] [referred: 7.10.2023] Available: https://www.reuters.com/world/europe/events-leading-up-russias-invasion-ukraine-2022-02-28/

Reuters 2023. Ukraine war: major developments since Russia's invasion. [e-publication] [referred: 8.10.2023] Available: https://www.reuters.com/world/europe/ukraine-war-major-developments-since-russias-invasion-2023-02-16/

Rigobon, R. and Sack, B. 2005. The effects of war risk on US financial markets. Journal of banking & finance, Vol. 29 (7), p. 1769-1789.

Schneider, G. and Troeger, V. 2006. War and the World Economy: Stock Market Reactions to International Conflicts. The Journal of conflict resolution, Vol. 50 (5), p.623-645.

Sharpe, W. F. 1964. Capital Asset Prices: A Theory of Market Equilibrium under Conditions of Risk. The Journal of finance (New York). Vol. 19 (3), p. 425-.

Shiller, R. J. 2003. From Efficient Markets Theory to Behavioral Finance. The Journal of economic perspectives. Vol. 17 (1), p. 83-104.

Shyam, H. P. 2023. Economic Interdependence and Realistic Interests: A Review of the Russia-Ukraine Conflict. Strategic analysis. Vol. 47 (3), p. 295-301.

Statista 2023. Russia-Ukraine war 2022-2023 – statistics & facts. [e-publication] [referred: 10.2.2023] Available: https://www.statista.com/topics/9087/russia-ukraine-war-2022/#topicOverview

Statistics Finland 2023. Enterprises. [e-publication] [referred: 6.2.2023] Available: https://www.stat.fi/tup/suoluk/suoluk_yritykset_en.html

Technology Industries of Finland 2022. Teknologiateollisuus on Suomen suurin vientiala - koostuu viidestä päätoimialasta. [e-publication] [referred: 10.2.2023] Available: https://teknologiateollisuus.fi/fi/talous-ja-toimiala/teknologiateollisuus-suomen-suurin-vientiala-koostuu-viidesta-paatoimialasta

Technology Industries of Finland 2023. Talousnäkymät 4/2023. [e-publication] [referred: 21.12.2024] Available: https://teknologiateollisuus.fi/wp-content/uploads/2024/08/T_Talousnakymat_4-2023-FI.pdf

Technology Industries of Finland 2024. Maailman talouden näkymät. [e-publication] [referred: 17.12.2024] Available: https://teknologiateollisuus.fi/talous-ja-tilastot/maailman-talouden-nakymat/

Technology Industries of Finland 2024. Talousnäkymät 4/2024. [e-publication] [referred: 21.12.2024] Available: https://teknologiateollisuus.fi/talous-ja-tilastot/teknologiateollisuuden-talousnakymat-4-2024/

Technology Industries of Finland 2024. Talousnäkymät-raportti 4/2023. [e-publication] [referred: 21.12.2024] Available: https://teknologiateollisuus.fi/talous-ja-tilastot/teknologiateollisuuden-talousnakymat-4-2024/talousnakymien-arkisto/

Technology Industries of Finland 2024. Talousnäkymät-raportti 1/2024. [e-publication] [referred: 21.12.2024] Available: https://teknologiateollisuus.fi/talous-ja-tilastot/teknologiateollisuuden-talousnakymat-4-2024/talousnakymien-arkisto/

Technology Industries of Finland 2024. Teknologiateollisuuden tavaravienti, 20 suurinta vientimaata, uusin kokonainen vuosi vs. sitä edellinen vuosi. [e-publication] [referred: 21.12.2024] Available: https://teknologiateollisuus.fi/graafit/teknologiateollisuuden-tavaravienti-20-suurinta-vientimaata-kuluva-vuosi-vs-edellinen-vuosi/

Technology Industries of Finland 2024. Tietoa toimialasta. [e-publication] [referred: 16.12.2024] Available: https://teknologiateollisuus.fi/talous-ja-tilastot/tietoa-toimialasta/

Thaler, R. H. 2016. Behavioral Economics: Past, Present, and Future. The American economic review. Vol. 106 (7), p. 1577-1600.

The Guardian 2023. Russia-Ukraine war live. [e-publication] [referred: 5.11.2023] Available: https://www.theguardian.com/world/live/2023/oct/29/russia-ukraine-war-live-belarus-lukashenko-talks-fighting

The New York Times 2023. How Russia’s war in Ukraine has unfolded, month by month. [e-publication] [referred: 7.10.2023] Available: https://www.nytimes.com/article/ukraine-russia-war-timeline.html

Tovar Jalles, J., Park, D. and Qureshi, I. 2024. Public and Private Investment as Catalysts for Growth: An analysis of emerging markets and developing economies with a focus on Asia. Journal of international money and finance. Vol. 148, p. 103166.

Vaihekoski, M. 2022. Rahoitusalan sovellukset ja Excel. 3rd ed. Turku, Painosalama Oy.

Van Bergeijk, P. A. G. 1989. Success and Failure of Economic Sanctions. Kyklos (Basel). Vol. 42 (3), p. 385-404.

Vasileiou, E. 2021. Behavioral Finance and Market Efficiency in the Time of the COVID-19 Pandemic: Does Fear Drive the Market? International review of applied economics. Vol. 35 (2), p. 224-241.

Vergara-Fernández, M., Heilmann, C. and Szymanowska, M. 2023. Describing Model Relations: The Case of the Capital Asset Pricing Model (CAPM) Family in Financial Economics. Studies in history and philosophy of science. Vol. 97, p. 91-100.

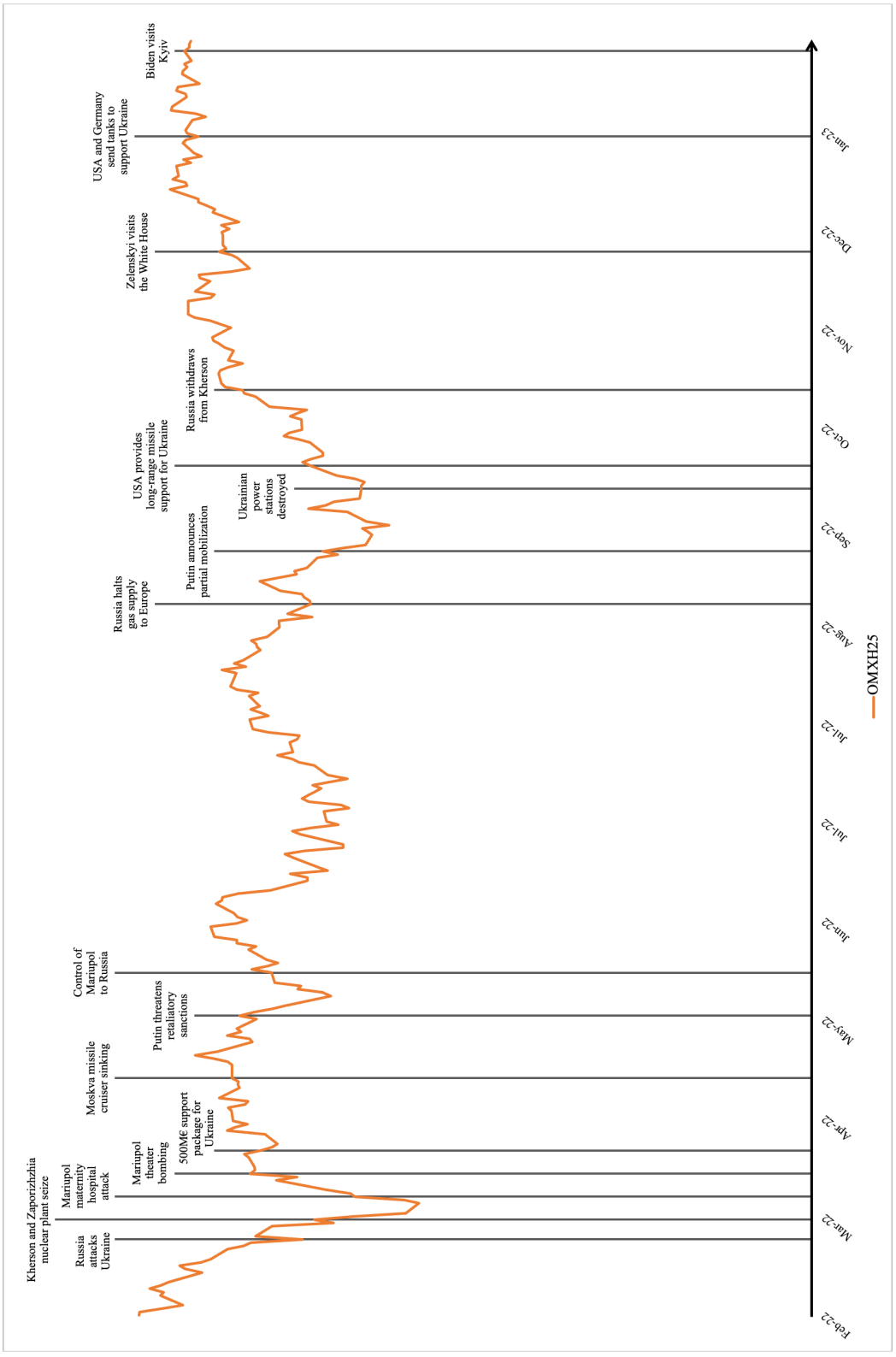
Vohra, R. 2001. Export and Economic Growth: Further Time Series Evidence from Less-Developed Countries. International advances in economic research. Vol. 7 (3), p. 345-350.

Wells, W. H. 2004. A Beginner's Guide To Event Studies. Journal of insurance regulation. Vol. 22 (4), p. 61.

Yen, G. and Lee, C. 2008. Efficient Market Hypothesis (EMH): Past, Present and Future. Review of Pacific basin financial markets and policies. Vol.11 (2), p. 305-329.

Yousaf, I., Patel, R. and Yarovaya, L. 2022. The reaction of G20+ stock markets to the Russia–Ukraine conflict “black-swan” event: Evidence from event study approach. Journal of behavioral and experimental finance, Vol. 35, p. 100723.

Yuan, K. 2005. Asymmetric Price Movements and Borrowing Constraints: A Rational Expectations Equilibrium Model of Crises, Contagion, and Confusion. The Journal of finance (New York). Vol. 60 (1), p. 379-411.

Appendices

Appendix 1. Timeline of the events and the OMHX25 index performance.