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Geopolitics and Market Risk

Do geopolitical events in the region influence the volatility of stocks traded in Helsinki?

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Abstract

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The purpose of that study was to identify whether geopolitical risk is a factor of risk in financial markets.
The research has been conducted using quantitative study. The risk of the market was measured using the volatility of the Helsinki leading index OMXH25 while geopolitical risk was measured using the GPR index consolidated by Caldara & Iacoviello for Finland, Russia and Ukraine. The data was collected for a period going from April 2013 to February 2025.
The result revealed that the linear relationship between GPR for those countries and OMXH25's volatility was visible only in the case of Ukrainian GPR.
The author recommends further investigation with different financial data, GPR and index and on various time periods.

Keywords: geopolitical risk, volatility, market risk

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List of Abbreviations

API	Application programming interface
BRICS	Organization of country (Brazil, Russia, India, China, South Africa).
CEO	Chief Executive Officer
D-Day	Day of the allies' counteroffensive in Normandy, France
GPR	Index measuring Geopolitical Risk
EndSARS	Decentralized social movement against police brutality in Nigeria
IPOB	Indigenous People of Biafra
LLC	Limited Liability Company
NaN	Empty cell on a Python data frame
OMX	Abbreviation of the Nasdaq Nordics.
OMXH25	Leading index of the Helsinki stock exchange. Composed of the 25 biggest companies listed.
OPC	Oodua People's Congress
RSS	The sum of the squared differences between observed and predicted values
RV	Realised Volatility
TSS	The sum of the squared differences between observed values and the mean of the observed values
UN	United Nation
USA	United States of America
USSR	Union of Soviet Socialist Republics
WWI	First World War

WWII Second World War

XX century 20th century, period from 1900 to 1999.

XXI century 21st century, period from 2000 to 2099.

Numerical dates will be presented in the format dd/mm/yyyy.

1 Introduction

Published in February 2022, the PWC CEO review for Finland is showcasing geopolitical risk as the third biggest risk facing firms behind cyber and macroeconomic volatility (PWC, 2022). On the 24th of the same month, Russian troops entered Ukraine with 120 thousand soldiers (Todd, 2024). This was perceived by many as a surprise and initiated a time of high instability. The next year geopolitics was still ranked third, but this time the main risk according to CEOs was inflation (PWC, 2024), which across 2022 was largely caused by the ongoing event in Ukraine, especially before the counter-offensive in the north towards Kharkiv and south towards the Dnieper River (Hamza, Hamida, Mili, & Sami, 2024).

As geopolitical risk is perceived by CEOs as an important risk factor for their business, geopolitical risk is likely to influence investors' perceptions of the riskiness of those firms. If a firm presents a higher risk, investors will expect a higher return on their investment. This can impact both debt and equity markets, leading to an increase in bond interest rates and possibly to a change in stock prices. It can therefore be expected that if a geopolitical news that can impact a company is reported to one of its investors, he will react to it and in most cases, it will lead to a fall in stock price for this company (Berk & DeMarzo, 2017). If looking at the debt and how geopolitical events can make debt raising more difficult and more expensive for businesses can be relevant, here only the equity side of this problem is considered. To observe this interaction between geopolitical risk and investor expectation, it is researched if there is a relation between Geopolitical risk in Finland, Russia or Ukraine and the volatility of the Helsinki leading index? Once this is identified the result is compared to determine which GPR index of the three is more related to the volatility of the OMXH25? This leads to answering the main question and to determine if geopolitical events around the Baltic Sea are impacting the volatility of the stock traded in Helsinki.

In the literature review (section 2), some concepts need to be defined such as the one of risk. Given that risk is a global topic and that each field of expertise has its own definition, the study is conducted using the work of Rejda & McNamara (2014) to understand the subtlety behind risk and its use in Finance. The concepts of subjective and objective risk, as well as the one of idiosyncratic risk need to be discussed alongside their use and measurement. Measurement of risk is also discussed through variance using the work of Poon (2003), Berk & Peter M. (2017) and Poterba & Summers (1984). As an entire part of the study is based on geopolitical risk, the work of Flint (2006) and Todd (2024) is used to explain geopolitics as a science and as a risk. Classical military theory such as Carl von Clausewitz (2006) and Sun Tzu (2017) is used to describe certain conflictual aspect of geopolitical risk. The measurement of geopolitical risk is discussed using the work of Caldara & Iacoviello (2022), Penn, Yang, Yu, & Iacoviello (s.d.) and Salisu (2023). Then is investigated how the index has already been used as a metric for financial study Ren, Cao, Liu, & Han (2023), Zhang, He, He, & Li (2022) as well as some alternative views on the subject with Vercueil (2014) and Taleb (2024).

In the methodology section is presented, the quantitative experiment as well as the different types of data used in the experiment. To measure how the market is evolving, a measure of volatility of the leading index (OMXH25) of the Helsinki stock exchange is used (VAIHEKOSKI, 2022). This index reflects the largest company, which given the small size of the exchange is a significant portion of it. It is then compared to the GPR index for Finland, Russia and Ukraine consolidated by Caldara & Iacoviello (2022). The financial data have been downloaded using Yahoo Finance (2025) and the geopolitical data comes from (https://www.matteoiacoviello.com/gpr_country.htm) (Penn, Yang, Yu, & Iacoviello, s.d.). The monthly volatility is calculated using daily returns of the OMXH25 computed using the price change. The analysis in this study is based on a simple linear regression to identify whether a relation can be found. The null hypothesis that we expect to reject for those linear regression analyses are: - There is no significant relation between Finland’s GPR and the OMXH25 volatility. - There is no significant relation between Russia’s GPR and the OMXH25 volatility. - There is no significant relation between Ukraine’s GPR and the OMXH25 volatility. The decision whether we reject or are unable to reject the null hypothesis for each experiment is made at the 10% confidence level as explained in the methodology section (4).

2 Literature review

This section presents the reference, definition and work used within this study. Primarily, the different vision of the concept of risk is presented before looking more on the specificity of finance through its measurement and later the geopolitical aspect of risk. Secondly, is presented how similar set of data has been used in previous research as well as alternative way to discuss the topic.

2.1 Risk

Overall, defining risk is a difficult exercise as each profession has its own definition.

> “Economist, behavioural scientists, risk theorist, statisticians and actuaries each have their own definition of the concept of risk.” (Rejda & McNamara, 2014)

In some way, the concept of risk is inherent in human society. Historically defined as uncertainty (Rejda & McNamara, 2014), risk can be found in most of the aspect of society. To define analyse what it is and define it more accurately, it is necessary to start by looking at some society level vision of risk, then discuss the topic of insurance before looking at it on a financial perspective and its measurement. This part is then concluded with a discussion around the specificities of geopolitical risk.

2.1.1 Risk on societal bases

To discuss risk efficiently it is necessary to discuss the concept of insurance which can be described as a psychological confidence necessary to act (Rejda & McNamara, 2014). As risk and insurance is inherent to all aspects of human interaction, we can find them in any aspect of society at all points in history. From a human behavioural perspective, the risk is the fear of losing something, it can be a such thing as “the fear of losing social status”. In which case the insurance is what makes you confident you will not lose your social status. Nobility (and globally the feudal class system), distinction, and professional title have for example developed through time to “guaranty” that the individual or family will not lose their status and rank (Le Bon, 2023). This example, intentionally away from the topic of finance, shows the idea that risk is a concept embodied by our society and not specifically related to the topic of Finance.

Slightly closer to the topic of this research, the risk of war. Defined by Carl von Clausewitz (2006) as “ an act of violence, engaged in order to constrain the opponent to our will”, “the continuation of politics by other means”, (von Clausewitz, 2006) wars are the example of a risk against which the traditional insurance doesn’t insure. Though the concept “if you want peace prepare for war” leads to think that in that case the insurance for a state would be its army (Machiavel, 2019).

2.1.2 Risk classification related to type of insurance

Risk can be classified in various ways, an aspect to consider is how to classify the risk factor studied as whether it is dealing with an objective or a subjective risk (Rejda & McNamara, 2014). The difference here is mostly regarding the predictability of the risk. As an example, insurance company should only deal with objective risk and part of 2008 crises is tied with the fact that insurance company started to ensure financial instruments that were subjective risk (Ferguson, 2010).

> “Objective risk (also called degree of risk) is defined as the relative variation of actual loss from expected loss. […] Objective risk declines as the number of exposures increases. More specifically, objective risk varies inversely with the square root of the number of cases under observation. […] Objective risk can be statistically calculated by some measure of dispersion, such as standard deviation or the coefficient of variation.” (Rejda & McNamara, 2014, p. 21)

This means that objective risk can be measured with a certain degree of accuracy, and this risk can be used to constitute a pool (of the same type of assets or life facing the same risk) to spread the potentiality of a loss. For an asset to be insurable, it require to be able to estimate the probability of a loss, to consolidate a pool of that risk and to be able to sell the insurance with the correct premium. Other factor such as avoiding catastrophic risk (a catastrophic event means that a lost occur to the entire pool or a vast part of it leading the pooling technique to collapse) needs to be considered for insurance (Rejda & McNamara, 2014) but we will not consider them for the following example.

Let’s now consider the risk of a car theft. There’s a large set of data on the probability of the car being stolen, we can consolidate a pool as many car owners are facing the same risk and as it’s important for them, they are likely to accept paying a premium to prevent it. For example, 4 465 of car theft have been reported in 2023 in Finland a number slowly declining since the year 2000 where it was at 26 391 (Statista, 2024). For this example, considering that the risk is that 1 car gets stolen out of a 1000 (0,1%). We estimate that the average price of a car would be 20 000 €. The risk for the insurance is therefore 0,1% to lose 20 000 €. If they can provide insurance to a 1 000 people for a risk premium of 20 € the pool would in theory be break even. However, according to the law of large numbers this would require a much larger pool to even the probability. In a real case scenario, the pool would also be more diverse as all the value of the cars differs. Additionally, component such as brand, model and geographies areas would also impact the probability.

But all risks are not objective, how to predict a war, a stock market crash or an abrupt change of policy? If some “wizards” claim publicly that they can do so, in most terms they would consider as subjective risk as they involve the behaviour (and irrationality) of individual or groups of human beings.

> “Subjective risk is defined as uncertainty based on a person's mental condition or state of mind. […] The impact of subjective risk varies depending on the individual. Two persons in the same situation can have a different perception of risk, and their behaviour may be altered accordingly. […] High subjective risk often results in conservative and prudent behaviour, while low subjective risk may result in less conservative behaviour.” (Rejda & McNamara, 2014)

The first difficulty raised by this distinction is that the line is small. If a car crash is also often the result of a human behaviour, it’s considered to be an objective risk as there’s large statistics around the probability of it happening and is therefore considered to be an objective risk (Rejda & McNamara, 2014). One line might be drawn on the intension, the car crash is rarely intentional, and if it turns out to be on a specific case, it would be excluded by the insurance policy. A war however is the result of successive decision and is often triggered by an individual with a political objective in mind (von Clausewitz, 2006). Part of what make stock market crash is also down to the decision made by several individuals to sell their participation, as they consider being in need of liquidity (Nesvetailova & Palan, 2008). If traditionally, insurance would not insure certain types of risk, re-insurer and hedge fund use sophisticated financial technique such as futures and options allowing to “insure” a variety of that would not be covered otherwise.

2.1.3 Risk applied to finance

While in the insurance industry risk can be used to designate the property or life consider for insurance (Rejda & McNamara, 2014). In economics and finance “risk” and “uncertainty” are often used to describe different concepts. In that case “risk” would imply a certain degree of accuracy in its prediction while uncertainty would designate an unpredictable event (Rejda & McNamara, 2014). It’s not rare to encounter the terms “loss exposure” that designates a potential financial loss. In finance, risk in general would therefore be considered as an element inducing a monetary loss.

The risk that is discussed in this research, “geopolitical risk” can be called subjective as it refers to the risk of tensions, conflict, wars and other sorts of political hazard in the designated region. All those factors are influenced by human decision and belief, involving their individual or collective judgment (Flint, 2006). (This risk area is investigated deeper in a further part (2.1.4).)

Another area of risk that worth being investigated when we look at the stock market is idiosyncratic risk. This experiment is not looking at firm specific behaviour, but at chunks of the market, it’s still a concept regularly discussed in research involving geopolitical risk.

> “Idiosyncratic risk is independent of market-wide phenomena and is due to factors affecting just the one company, such as mismanagement, a factory fire, an invention that renders a company's main product line obsolete, etc.” (VERNIMMEN, Quiry, Dallocchio, Le Fur, & Salvi, 2017)

In the research that involves Idiosyncratic risk and geopolitical risk the bridge is made based on the fact that idiosyncratic volatility of firm correlation to geopolitical risk parameter might differ? Depending on whether they are partially owned by the government, their industry, the location of their supplier… (Ren, Cao, Liu, & Han, 2023)

2.1.4 Variance as a measure of risk

Once the topic of risk is considered, the need to measure such a parameter needs to be discussed. In the field of finance and especially when it comes to sock markets, the metrics of risk are often a measure of variance and standard deviation so called volatility.

> “In finance, volatility is often used to refer to standard deviation, σ, or variance, σ2, computed from a set of observations.” (Poon, 2003)

In other terms, to get a measure of risk we first need a “set of observations” in the case of stocks and index we often observe the return of the stocks. This would typically be the change in price over a period, accounting or not for dividend. (We will discuss the specific case of this study in the methodology section 4.) This return, often expressed in percentage, will then be the bases of a standard deviation or variance analyses. (The standard deviation is the square root of the variance). The standard deviation gives us a metric of how much the return has varied during the studied period. Multiplied by the number of occurrences in the period and expressed in percentage it gives us a measure of volatility (Berk & DeMarzo, 2017). As volatility is fluctuating depending on the period covered by the “set of observations”, once computed for a series of successive periods, such as a measure of volatility of daily returns for each month of a year, will allow to estimate how the spread in value and therefore the risk have evolved during the year. (Formulas used for calculation are provided in section 4.)

The next question is what is this risk measure used for? In general, in finance, risk is shaping investor’s expectation of the return to aim for. The riskier is an investment, the higher they expect the return on investment to be. The volatility can be used to analyse the riskiness of a stock but can also in some case be directly used in calculation of other factors. In the case of a portfolio of stocks for example, variance is used in the calculation to figure how stocks are related between them. We also use individual stock volatility to calculate the risk of a diversified investment. The volatility is therefore influencing investor’s expectation for the performance of a stock but also their selection and repartition in a portfolio (Berk & DeMarzo, 2017).

In the case of this research (as will be discussed in the methodology section 4.), we will use volatility as a monthly measure of risk of the OMXH25 index that will then be compared in a linear regression with the GPR value to determine if there is a link between geopolitical risk and market risk.

When it comes to the limitation, the first one is that this measure of risk is a measure of historical risk and therefore do not represent the current risk nor the future risk (Berk & DeMarzo, 2017). In the case of this research, this parameter will not be considered as being a limit as the GPR indexes are also historical data and that we do not aim to use one to predict the other but to understand if one could have influenced the other in the past.

We can also consider as a problem the fact that as investor’s expectation is influenced by the volatility, it then influences the price fluctuation on which calculation of volatility is based. However, it seems that the impact that volatility has one stock price is limited in terms of time and magnitude (Poterba & Summers, 1984).

Additionally, variance and standard deviation as measure of risk themselves can be questioned. As working with them would give the probability of some catastrophic event such as the 2008 financial crises as negligeable parameter when we can observe such phenomena every 10 to 20 years. If this might be linked to some system parameter that a variance analysis would not consider, some other measure of risk in financial market might be better suited for certain types of analyses (Eftekhari, Pedersen, & Satchell, 2000).

2.1.5 Geopolitics as a risk factor

The main difficulty of using geopolitics in research comes from the fact that the word is widely used to describe various things. Is it the study of politics of each country? A specific study of the concept of nation states? A synonym of foreign affairs? Or a "buzz word" gathering anything that result from a political decision somewhere in the world? The precise definition of what is discussed here is therefore important.

Primarily geopolitics is purely a field of research, there is no geopolitician (as there is politician) in the sense that no one is practicing it. If geopolitics as human science study the outcomes of decisions made by human beings, these individuals do not aim to "change geopolitics" their ambition are likely to be political, with the aim of impacting their interest (Flint, 2006).

Geopolitics is etymologically tied to "geography" (the science studying places and population) and "politics" (the action of controlling a system). It could therefore be considered as the study of how politics influence geography (frontier, populations, resources…). But as it will be studied here from the angle of how investors are preserving geopolitical risk and acting relative to it, only the part of what is studied by geopolitical science and reported to a broad audience needs to be considered. In that alternative, we must face the fact that it's often narrowed down to conflict, diplomacy, military, war and terrorism. If we will consider all the above, for simplification purposes we will accept the following short definition.

> "Geopolitics, as the struggle over the control of spaces and places, focuses upon power, or the ability to achieve particular goals in the face of opposition or alternatives." (Flint, 2006)

The core research used for the geopolitical side of the study is explained in Measuring Geopolitical Risk (Caldara & Iacoviello, 2022). As this work is quite recent it is difficult to picture how we could have performed a similar work prior to 2021. One of the potentialities that have been explored was to use the evolution of countries national debt rate of interest and credit rating as a base of how risky they were perceived from the market's actors.

Geopolitical risk is by essence tied with country specificities and variety of parameters, a difficult element to measure accurately. But once we have acknowledged the fact that even if an index is not perfectly accurate it can still be useful. “All models are wrong, but some are useful.” (Box, 1979)

> “It would be very remarkable if any system existing in the real world could be exactly resented by any simple model. However, cunningly chosen parsimonious models often do provide remarkably useful approximation.” (Box, 1979)

In the case of GPR, the use is to be able to get a base allowing to perform the calculation and a study of geopolitical risk fluctuation. We can consider it, despite its problems, as being relevant enough for much research in the fields of economics and finances (Ren, Cao, Liu, & Han, 2023). Some other interesting parameters are used by geopolitical researcher such as suicide rate fluctuation (to indicate people acceptation of regimes), infant mortality (relevant to study corruption level), electoral results, number of doctoral study fluctuation (to identify elites migration) … (Todd, 2024). If the use of those statistics is interesting to understand specific geopolitical parameter, they do not offer a wide view. GPR also has an important quality when it comes to economical study, as it is based on newspapers (Caldara & Iacoviello, 2022) it might not offer a reflection of the truth but a reflection of investor perception of the truth. The worst event could occur somewhere but if investors does not learn about it, it is unlikely to influence any market metrics.

Therefore, in this research GPR consolidated for Finland, Russia and Ukraine to represent the geopolitical risk is used. (Penn, et al., s.d.) This index is text based and consolidated using Newspaper as an input (Caldara & Iacoviello, 2022).

More concretely, to consolidate a such index, you primary must identify a list of keywords that are looked for in the selected newspaper. In his work to consolidate a GPR index for Nigeria, Salisu (2023) describe his list of keywords as:

> “For example, keywords such as “Biafra", “separatist”, “IPOB", "Indigenous People of Biafra", "OPC” , “Oodua People’s Congress”, “piracy”, “pirates”, “EndSARS”, and “bandits” are peculiar to Nigeria” (Salisu, et al., 2023)

In the case of Finland, the keywords would need to correspond to the risk of the region and could contain, for example “Russia”, “Cyberattack”, “Foreign interference”, “shadow vessel” …

Once the keywords are identified, in the best-case scenario, the data is taken from various local newspapers and a few international ones. Even in this configuration, the index reflects “the view” of the selected publication and are rarely based on information as it might be published in a non-communicating system (such as Russia related to the USA). As an example, the information provided by a Finnish news source is unlikely to provide a Russian vision of events. Therefore, the index will reflect those possible biases.

The index used for that study is based on The New York Times, Chicago Tribune and The Washington Post (Penn, et al., s.d.). If those sources are known and recognised worldwide, they are all from the United States of America and will therefore represent neither local view nor alternative systems view. If acknowledging those limitations is important, this should not impact the point of this research as most of the investors investing in the Finnish market are from a similar side of the world (Statistics Finland, 2023) and therefore are likely to base their decision on information provided by similar papers.

2.2 Existing research

Geopolitics being considered by CEOs as an important risk for their businesses (PWC, 2022), researchers have investigated heavily the area. Two axes can be considered there, the study of geopolitics and the research regarding its use in financial and economics sciences. Considered alone Geopolitics, as a human science have developed across the age as other science related to it evolved too (Flint, 2006) (history, geography, political science, military theory, philosophy). If we take the example of military strategy, whether we read Clausewitz, Sun Tzu or Cesar, the concepts are similar across the time. Appreciation of the conditions, economy of war, strength ratio, resources and other parameter (Sun Tzu, 2017) have not changed much across the time. What has changed however is the mean of that war and this need to be acknowledged by contemporary researcher (Todd, 2024).

When it comes to the use of geopolitics in economics, an important volume of research has emerged in the last few years. This follows the publication from Dario Caldara and Matteo Iacoviello entitled Measuring Geopolitical Risk that set a wider base of the GPR index than what was previously available. (Caldara & Iacoviello, 2022) This index is a good base for economics and finance studies as it follows clear trend of how geopolitical risk was perceived by the media in the USA. Additionally, they have consolidated this index for a large variety of countries (Penn, Yang, Yu, & Iacoviello, s.d.) and keep that data available for download, updated on monthly bases.

This GPR index has been used in a wide range of studies, testing relationship with various financial instruments in various geographical areas (Lu, Gozgor, Huang, & Lau, 2020). For example, it has been used to see how idiosyncratic volatility of firm was reacting to geopolitics in the Chinese market. This gave interesting result showing an overall correlation with variation in the intensity depending on types of ownership or types of industry (Ren, Cao, Liu, & Han, 2023). Studies have also been performed on how GPR correlates with stock market volatility (Zhang, He, He, & Li, 2022), this studies are used as a base for our experiment (section 5).

The constitutions of more accurate version of the GPR index, based on a mix of international and local sources have also been a trendy element in research. Salisu have, for example, worked on consolidating a more accurate index for Nigeria using 10 Nigerian newspapers to work with a more precise reporting of guerilla action (Salisu, Salisu, & Salisu, 2023). If this is interesting with the aim of having a more accurate representation of geopolitical risk to remove part of the American bias of the GPR index consolidated by Caldara & Iacoviello (2022). We can also criticize Salisu's (2023) index from an economics perspective if we buy on the assumption that market react to the headline, as those local sources' headlines will be less reads by international investor. Though the same question can be asked about the work of Caldara & Iacoviello (2022) on how investors from China would for instant be reported headline differently than in the USA.

Another part of the literature takes a different angle and would for example analyse how financial and economic element have impacted geopolitical event. Such as the impact of sanctions on economies, as studied by Julien Vercueil about the 2014 sanction imposed by western powers on Russia following their invasion of Crimea (Vercueil, 2014).

Some other such as Nassim Nicolas Taleb claims (at the 2024 Swiss Economic Forum) that geopolitical risk is not necessarily relevant to look at when you study the market. As geopolitical event such as a potential World War three would be according to him determined by markets themselves (Taleb, 2024).

3 Context

This study relies on two main aspects which are on one side the geopolitical risk for Finland, Russia and Ukraine and on the other the Helsinki stock exchange and its leading index. In this section, both are contextualised to cover the elements that are the most important regarding this experiment.

3.1 Geopolitical context

As geopolitical risk relies on real life event, some basic knowledge of this event is essential to any work related to geopolitics. As the GPR index that is used is consolidated on historical data, the variation is followed and the major event referenced by Penn, Yang, Yu, & Iacoviello (s.d.) to understand the XX and XXI century geopolitical context of Finland, Russia and Ukraine.

3.1.1 Finland

Finland geopolitical history has been relatively quiet across the past 100 years compared to some of the others European region. Here are discussed some of the major events related to Finland since 1900, as a part of the Russian Empire and later as an independent nation.

Figure 1 Historical GPR value for Finland since 01/01/1900 (Penn, et al., s.d.)

The team consolidating that historical GPR database (Penn, et al., s.d.), provides some information on what event are the 15 highest points related to. The first peak dated of August 1914, corresponds to the offset of World War I. The month of August 1914 symbolises the beginning of the major hostility with the German invasion of France.

> "On August 6th the great deployment began; 550 trains a day crossed the Rhine bridges, and by the 12th the seven German armies (1,500,000 men) were ready to advance. Over the Hohenzollern bridge at Cologne a train passed about every ten minutes during the first fortnight of war. This vast railway movement was a masterpiece of organization, but when the deployment, completed on August 17th, merged into the forward march, the friction of war soon revealed weaknesses in the German military machine and its control." (Sir Liddell Hart, 2014)

An increase of GPR is observed in 1917, year in which the conflict starts to change with the Russian revolution that led to a civil war and later to Finland's independence (Kirby, 2011). It also marks the entry of the United States of America in the conflict (Sir Liddell Hart, 2014). The second highest point is dated February 1918 and designated as WWI (Penn, et al., s.d.).

After a relatively long period of low GPR (1922-1938), the value starts going back up in September and October 1939 with the offset of World War II (Sulzberger, 1985). In December 1939 the GPR index for Finland reached his highest point ever due to the Battle of Suomussalmi. This battle is the symbol of the struggle of Finland against the much larger Soviet Army during the Winter War. (Författare, 2009).

It can be assumed that one of the reasons to explain the much greater value of the index during WWII compare to WWI can be due to a better coverage of the events by the American newspaper used to consolidate the index (Caldara & Iacoviello, 2022).

Five other GPR hight points must be addressed regarding WWII such as June and November 1941, labelled “Continuation War” (Penn, et al., s.d.). The year 1944 is the last “great” move of the index concerning WWII within February and March1944 the “great raids against Helsinki”. The three raids took place during the night of the 6-7th, 16-17th and 26-27th of February 1944. During those raids, soviet aircraft delivered 2604,5 tons of explosives on Helsinki. This is also considered in Finland as a great victory for their Anti-Aircraft defence (Alanen & Lappi, 2006). A significant peak is also visible for June 1944 due to “D-Day”.

After WWII and during the cold war, the GPR was relatively low with some isolated picks. In March 1948 with the “Soviet war threat”, the “Note crisis” in November 1961, the “Helsinki summit” in 1990 and more recently in 2018 with another “Helsinki summit”. Since January 2022 we can see a new raise in the GPR due to the tension with Russia.

3.1.2 Russia

Russia, as an empire in the early XX century, later as the gravity centre of the USSR until 1991 all the way the contemporary area has been particularly active in the geopolitical life of the world (Todd, 2024). In this part, the discussion focuses on some of the major events in which Russia have been involved (that have been widely reported in the west) and that explain part of the contemporary situation.

Figure 2 Historical GPR value for Russia since 01/01/1900 (Penn, Yang, Yu, & Iacoviello, s.d.)

The historical GPR index for Russia appears to be fluctuating more than the Finnish one. If the historical high for Finland's GPR is 2,83% with an average of 0,06%, the Russian one have an average of 1,05% and a record at 5,68% (Penn, Yang, Yu, & Iacoviello, s.d.).

This is partially explained by the more active conflictual history of Russia in various places. But it's important to note that the news coverage done by The New York Times, Chicago Tribune and The Washington Post (Sources on which the GPR is computed (Caldara & Iacoviello, 2022)). Are likely to have discussed more extensively what happened in Russia than in Finland. As for the Finnish index, a note is assigned to each of the 15th highest peaks (Penn, Yang, Yu, & Iacoviello, s.d.).

As the record starts in 1900, the first peak is dated in February 1904 and labelled as the Russo-Japanese War. This war started the 8th of February 1904 by Japan to counter Russian expansion in Asia, especially near Korea and around Vladivostok (Encyclopaedia Britannica, 2025). This war, won by Japan had for consequence to increase Asian and especially Japanese confidence in their resistance capacity (War GB, 2018).

The two following peaks are related to WWI where Russia was massively engaged on various frontline until their revolution in 1917 (Sir Liddell Hart, 2014). The WWII was also an active time for Russia, then part of the USSR, with first a pact with Germany to gain part of Poland and later with the Barbarossa operation where Germany declared war to the USSR. Later in the conflict, significant event was reported with Stalingrad battle, the battle of Kursk and other significant counter offensive (Sulzberger, 1985).

Figure 3 September 15, 1962: photograph of the Soviet large-hatch ship Poltava on its way to Cuba (National security archive, 2025).

Post world war time was active too for the USSR with the Korean War in which USSR was involved alongside China supporting North Korea in their offensive by providing equipment such as aircraft but also by maintaining troops in the nearby Siberia (O'Neill, 2000). Then in November 1956 the following peak is due to their involvement in the Suez crises (Kashtanov, 2018). With USSR’s nuclear threat in 1961, the GPR index reaches a new historical high in October 1962 with the Cuban Missile crises. At that moment, USSR, allied with Cuba tried to establish nuclear missile on the island, located close to the USA. This led to one of the highest tensions in the Cold War history with the USA threatening to engage military action if the boat were not turning back (Tuttle & Ubriaco, 2023).

In October 1973, the peak is designated as the Yom Kippur War. This war between Israel and a coalition leads by Egypt and Syria (Walker, 2023). The peak in January 1980 is related to the Soviet invasion in Afghanistan which ended up being a very costly and difficult period for the USSR.

In 2014 and especially Since 2022 several peaks can be observed but are not labelled (Penn, Yang, Yu, & Iacoviello, s.d.). However, they are most certainly related to the 2014 annexation of Crimea, and the invasion of the Ukrainian territory, since February 2022.

3.1.3 Ukraine

The case of Ukraine in this list of indices is relatively specific as the country did not exist as such during the period covered by Penn, Yang, Yu, & Iacoviello (s.d.) until 1991.

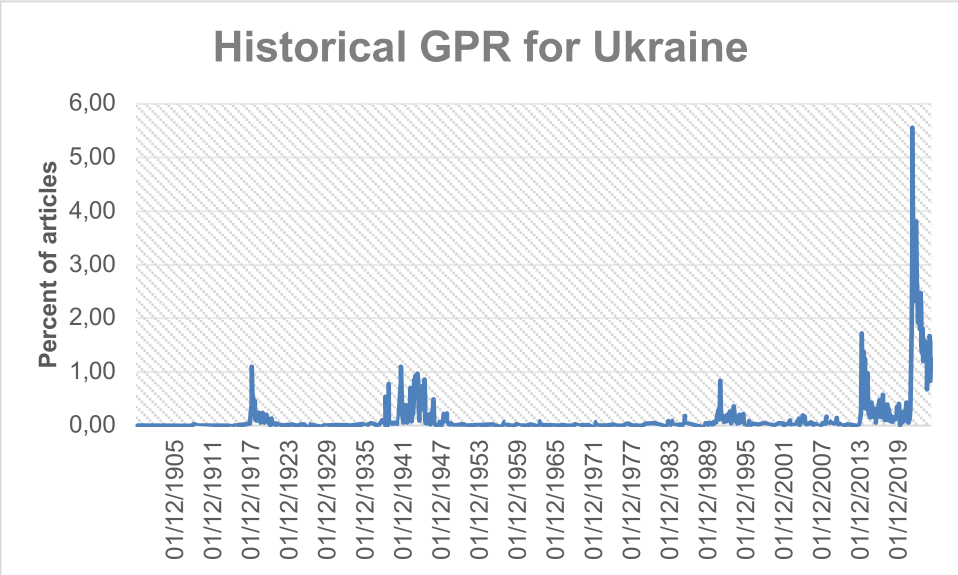

Figure 4 Graph representing the historical GPR for Ukraine since 1900.

As Ukraine was not differentiated in news report from the USSR in most of the of the news. Only small peaks can be seen in 1917 where it has certainly been mentioned regarding the Russian revolution as part of the former Russian Empire and newly created Union of Soviet Socialist Republics in which it was one of the so cold Republics. In 1918, the battle of Kiev is represented by the first peak. Around WWII, Ukraine's GPR is also razing as the theatre of the "Dnieper offensive" (Penn, Yang, Yu, & Iacoviello, s.d.). In 1991, the rise in GPR is due to the dissolution of the USSR where it became an independent republic.

The index then stayed quiet until 2014 and the Russian annexation of Crimea (Penn, Yang, Yu, & Iacoviello, s.d.). Later the battle with the Donbass in the oblast of Donetsk and Luhansk, the index continues to fluctuate. In February 2022, the Russian invasion of Ukraine raised the index to its historical Hight.

3.2 Helsinki stock exchange

This research is conducted based on the Nasdaq Helsinki, trading platform located in Helsinki, Finland. The exchange is part of the Nasdaq Nordic since the 3rd of September 2003. It's a relatively small exchange with most companies that would be considered "small cap" on most of the main exchange (FINRA, 2022). As “small cap” tends to react more than “large cap” (Khanra & Dhir, 2017) it’s particularly interesting for us as the aim of this research is to see how stock price is affected by “geopolitics”.

3.2.1 History

The Helsinki stock exchange has open for trading on the 7th of October 1912 (VAIHEKOSKI, 2022). This makes it a relatively young stock exchange. At that time, Finland was part of the Russian Empire (until 1917). Originally there were 30 companies listing stocks there. In 1935 the trading switch to a mechanical system “arguably one of the most advanced in the world at the time” (VAIHEKOSKI, 2022). This device will be replaced in 1990 to an electronic trading system.

Being first established as a cooperative between banks and traders, the Helsinki stock exchange was then converted to an LLC in the mid 90s. In that period, the Helsinki stock exchange started the merger and acquisition period with first two Finnish derivative exchanges and later in the early 2000 with the Tallinn and Riga stock exchange. In 2003, the Helsinki stock exchange merged with the Stockholm exchange to create the Nasdaq Nordic. Since that moment, the Helsinki stock exchange is named Nasdaq Helsinki.

The leading index of the Nasdaq Helsinki is named OMXH25 and follows the 25th highest valuated company listed there. The trading open’s at 10am eastern European time to be synchronised with the opening of the bigger floor such as Paris or Munich that open at 9am, central European time (VAIHEKOSKI, 2022).

3.2.2 Currently listed companies and OMXH25.

There are currently two markets under the Nasdaq Helsinki, the “Main market” and the “First North market”. In the beginning of March 2025, 49 companies were listed on the First North market and 134 on the main market for a total market capitalisation of 268B € (Nasdaq, 2025).

The current largest company listed in Helsinki is Nordea Bank 44,69 B €, followed by KONE 27,98B € and Nokia 25,05B €. The 31st company listed in Helsinki, Alma Media is the first one bellow 1B € of market capitalisation.

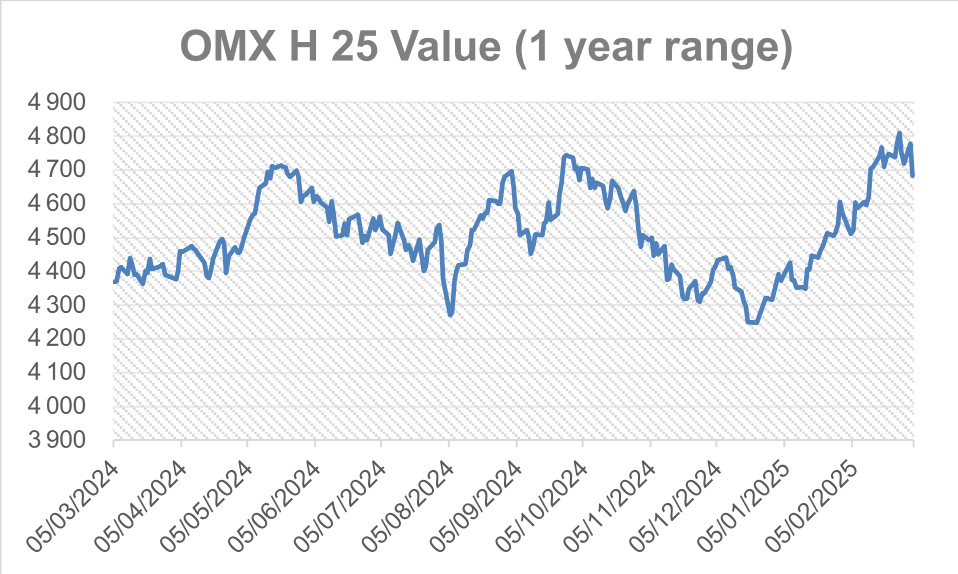

Figure 5 Graph of OMX Helsinki 25 index value (1 year range) (Nasdaq, 2025).

The OMX Helsinki 25, is the index that tracks the 25 biggest Finnish companies. We can observe on the previous graph that the value is on the 1-year period fluctuating between 4 200 and 4 800 with relatively abrupt fluctuation.

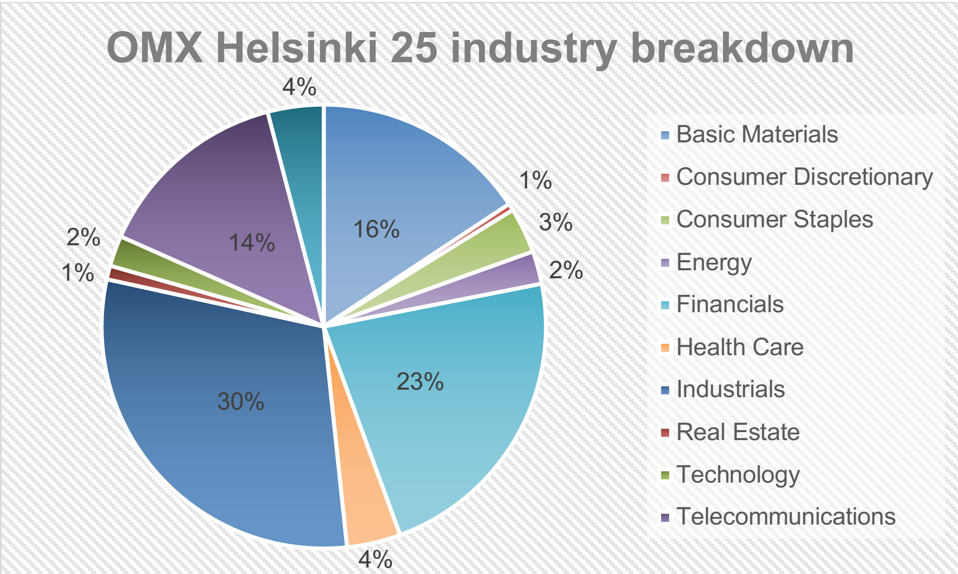

Figure 6 Pie-chart of OMX Helsinki 25 index breakdown (Nasdaq, 2025).

Even if Finland's technology industry is well-known, within the larger companies the business is mostly conducted in the field of Industry, Finance, Basic Materials and Energy.

4 Methodology

In this section, the process of the experiment performed in section 5 is discussed. Starting with an explanation of the data collection process, the experiment methodology, a presentation of the data and some complementary reading tools.

4.1 Origins of the data

The linear regression performed in section 5 requires several types of data sets to work with for both the financial and the geopolitical risk aspects. In this part, the collection technique of the data is discussed.

4.1.1 Financial data collection

In this study, we use financial data is downloaded from Yahoo Finance using the python API yfinance 0.2.54. on the 13th of February 2025.

Adjusted closing value for the OMXH25 daily data index were downloaded using the programs in appendix 1.

```
                ^OMXH25 ^OMXHLCGI   ^OMXHMCGI   ^OMXHSCGI
Ticker          ^OMXH25 ^OMXHLCGI   ^OMXHMCGI   ^OMXHSCGI
Date
2013-04-02  2355.449951       NaN  114.226997  102.712997
2013-04-03  2353.659912       NaN  114.575996  102.696999
2013-04-04  2325.270020       NaN  114.991997  102.889999
2013-04-05  2285.939941       NaN  113.785004  102.898003
2013-04-08  2267.340088       NaN  112.644997  102.667000
```

Figure 7 Python database sample illustration.

This gives a database with all the value starting from the earliest record of the API on the 1st of January 2000. Even if an attempt is made to get earlier record, the API cannot provide them. “NaN” indicates that there is no value, it results from the fact that for some indexes the data is available from a later date. As an example, the data for the OMXH25 index (^OMXH25) becomes available in the month of April 2013 (Yahoo Finance, 2025). The resulting database is composed by the OMXH25, on which was computed monthly volatility. The OMXH25 value (recorded on the 1st of each month) and monthly volatility has later been merged with the GPR index for Finland, Russia and Ukraine.

The financial data is not subject to much debate as its simply a consolidation of all the historical recorded information. The calculations are based on the adjusted closing value so stay constant in the analyses. The Volatility and the return are calculated as further explained in the methodology section (4).

4.1.2 GPR data collection.

The GPR data (Penn, Yang, Yu, & Iacoviello, s.d.), historical and monthly, for Finland, Russia and Ukraine have been downloaded from (https://www.matteoiacoviello.com) on the 13th of February 2025. On this website, the team allows to download data for several countries in various regions, this index is expressed in percentage of articles. For the calculation we will use the data since the month of April 2013 as the OMXH25 data is available since then.

The data set provided display a large variety of countries with both historical GPR and monthly GPR, the indexes are constantly updated witch gives the opportunity to perform studies on recent events. If it is considered that the closer is a data point, the more relevant it is to construct expectation of the future, this source of data can therefore be very helpful. As discussed in the previous section (2.1.2), the GPR index consolidated by Penn, Yang, Yu, & Iacoviello (s.d.) can present a few limits. Notably, its consolidation on American news sources (Caldara & Iacoviello, 2022) with its bias and the increase in the coverage of international event across time (ex: event happening in Finland is likely to be better reported in the New York Time in 2000 than in 1900). This leads for example to a much greater percentage of article covering the current Russo-Ukrainian war than the WWI and therefore a much greater GPR.

4.2 Experience and methodology

In order to perform a linear regression experiment to estimate the linear relation between geopolitical risk and the OMXH25 index volatility various calculations are detailed in this part. From the calculation of the return, variance and standard deviation (4.2.1) that are used in the experiment to the linear regression calculation itself (4.2.2), the formula and explanation are presented in the following parts.

4.2.1 Return and volatility calculation

For the linear regression study, a measure of volatility is used. To calculate it, a return in percentage based on the daily adjusted closing value of the OMXH25 since the 1st of April 2013 is calculated in the first place.

$$r = \frac{v2 - v1}{v1} \times 100$$

Where r is the return (percentage price change), v1 is the value of the previous day and v2 the value of the day. Then the volatility for the month is computed by calculating the standard deviation (σ) of the daily returns within the month.

$$\sigma = \sqrt{\frac{\sum_{i=1}^{N}(r_i - \mu)^2}{N}}$$

Where N is the number of trading days in the month, r_i the return on day i and μ the mean of the daily return. Then is multiplied the standard deviation with the square roots of the number of trading day to get a metric of realised volatility (RV).

$$RV = \sigma \times \sqrt{N}$$

Those data are merged with the GPR value for Finland, Russia, Ukraine and the OMXH25's return per mouth.

4.2.2 Experiment process

The linear regression experiment itself is performed using tools provided by Microsoft Excel software. We will mostly focus on 4 value R squared, Significance F, coefficient and P-value.

R squared (r^2) gives the proportion of the value that is determined by the model. As R squared is always in the interval [0;1] it can be considered that an R squared result of 0,5 would mean that 50% of the value is explained by the model. This leads to assume that the other 50% are not.

$$r^2 = 1 - \frac{RSS}{TSS}$$

Where RSS is the sum of the squared differences between observed and predicted values, and TSS the sum of the squared differences between observed values and the mean of the observed values (Ouko, 2024).

Using Significance F by comparing it to Alpha to identify if the model is a good one. For it to be so Significance F value would need to be smaller than Alpha.

The coefficient indicates what is the multiplication factor of the relation. It's visible as the slope coefficient of the tendency line in the scatter plot of the value observed.

The P value will be used the same way as Significance F in order to know if the coefficient is relevant or not. Note that P-value and Significance F are often close or identical.

$$P - value = \frac{\hat{p} - p0}{\sqrt{\frac{p0(1-p0)}{n}}}$$

Where $\hat{p}$ is the sample proportion, p0 is the assumed population proportion in the null hypothesis (in our case, there is no relation between the GPR of [Finland or Russia or Ukraine] and the OMXH25 volatility) and n is the sample size (Cuemath, s.d.).

To accept or reject the result an Alpha of 0,1 (10% confidence level) is used. If the value for Significance F and P-value is smaller than alpha, the null hypothesis will be rejected.

4.3 Data presentation

In this section, is presented and discussed some graphs to introduce the data that is used in the study on the correct time scale (01/04/2013 to 01/02/2025).

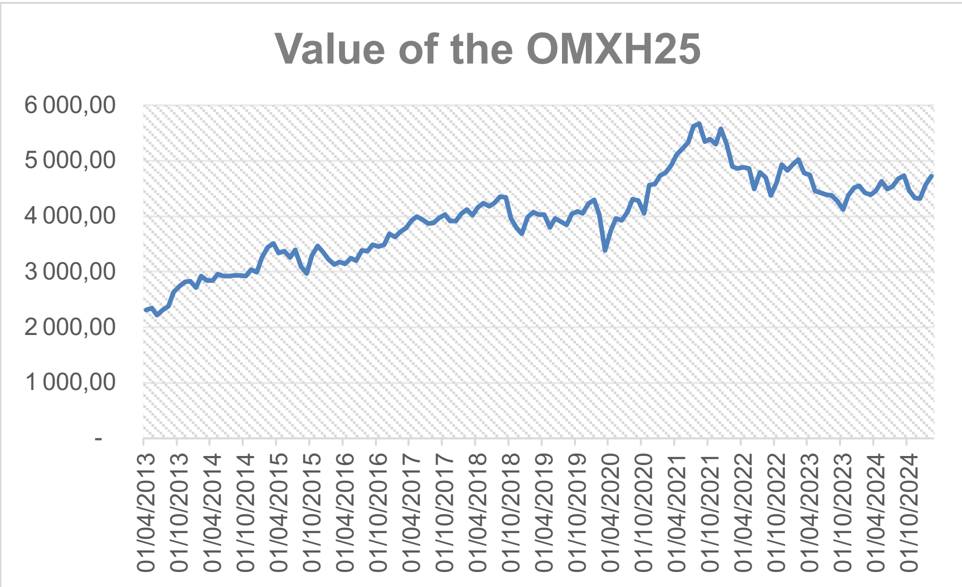

Figure 8 Graph representing the value of the OMXH25 index since the month of April 2013 (Yahoo Finance, 2025).

It can easily be observed through that graph that the leading index of the Helsinki stock exchange has been following a logic increase of value. Even if it has not recovered yet to its pre-covid levels (and might not necessarily do so in the coming time).

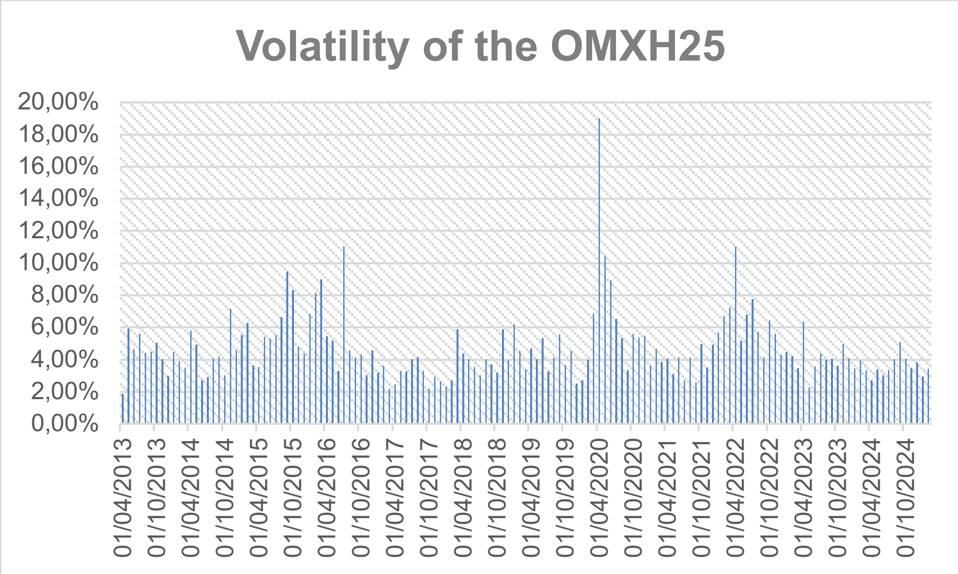

Figure 9 Bar graph presenting the percentages of monthly? volatility of the OMXH25 since April 2013

In the previous section risk and specifically geopolitical risk is extensively discussed. If volatility is considered as a measure of risk, this graph allows to easily visualise that risk in financial market can be down to a variety of factors, geopolitical risk being one of them. The visible peak in April 2020, can be affiliated to the lockdown imposed by government all around the world in response to the Covid-19 pandemic (Dunford, et al., 2020).

Figure 10 Graph presenting the GPR for Finland since April 2013 (Penn, Yang, Yu, & Iacoviello, s.d.).

Looking at geopolitical risk, it has been relatively quiet when it comes to Finland’s GPR, with small increase in 2018 and since 2022 mostly related to the tension with Russia in the Baltics Sea. Though if the fluctuation exists the absolute value of the index stays below 1%. As the index is consolidated on American newspaper (Caldara & Iacoviello, 2022), it can be input to the little reporting done by those sources about event appending in Finland. However, it is important to admit that despite the interest of local news sources for “geopolitical tensions”, nothing can be compared to what is happening in the two other studied regions.

Figure 11 Graph presenting the Russian and Ukrainian GPR since April 2013 (Penn, Yang, Yu, & Iacoviello, s.d.)

Representing the GPR data for Russia and Ukraine (for the studied period) on a same graph allows to visually illustrate the ties between the two. It is logical given that they were the theatre of some of the major geopolitical events during the last decade. Ukraine dropped lower than Russia between the 2014 and 2022 events despite the conflict with the separatist in Donetsk’s and Luhansk’s oblasts. Probably for the same reason than discussed in the case of Finland. When it comes to Russia, the difference with Ukraine is probably tied with their activity in the rest of the world such as in Syria, Georgia and their investment in international organisation such as UN security council, and the BRICS.

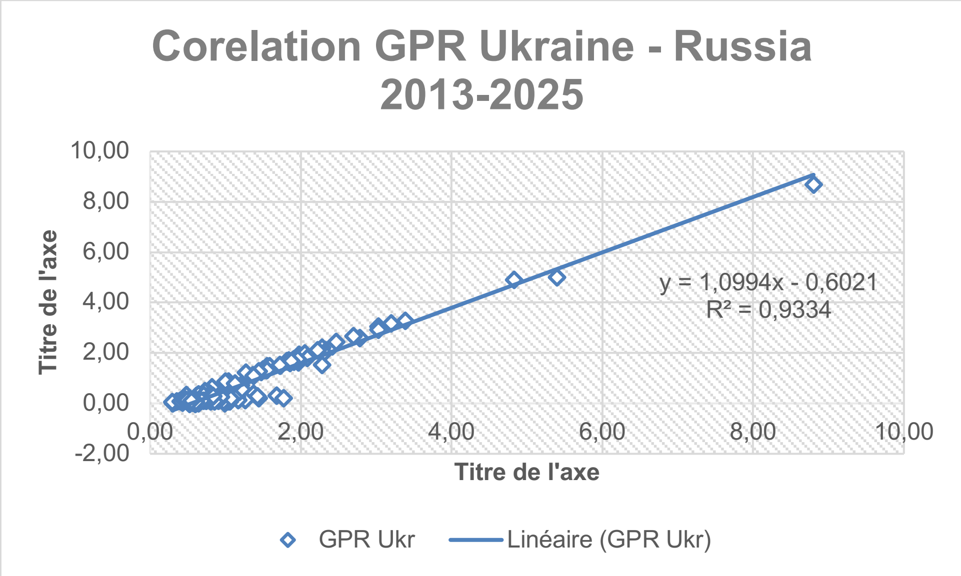

Figure 12 Linear regression representing the linear relationship between Ukrainian and Russian GPR (01/04/2013 - 01/02/2025).

After the visual evidence of the previous graph, this one present the statistical evidence of this relation. With a coefficient of determination of 0,97 the relation between those two countries GPR is extremely strong and show how they are tied. Then the question of why should be studied the relation to OMXH25 with both was raised. It found its answer through the desire to determine which one have the most impact on the OMXH25 and therefore how are other action of Russia in the world, impacting investor vision on the Finnish market.

5 Analyses and discussions

In these last analysis sections, is presented the regression results and discuss their relevance, comparing them with one another with the aim to answer the initial research questions. If a strong relation is not expected. (As many other aspects of risk are considered by investors.) It is expected to find statistically significant value that would indicate a certain link between the two parameters.

5.1 Analyses

While presenting the results, 4 questions aim to be answered. Is it a good model? How much of the data is explained by the model? What is the coefficient that ties both variable? Is the coefficient significant?

In order to reject or not the analyses regarding the quality of the model and the significance we will base it with an Alpha of 0,10. A 10% significance will be looked for, mostly because the experiment looks at one specific aspect of risk I relation to a specific index in a specific market.

5.1.1 Relation between Finland’s GPR and OMXH25 index

Regression Statistics	
Multiple R	0,088876281
R Square	0,007898993
Adjusted R Square	0,000862816
Standard Error	0,021562825
Observations	143

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,000521971	0,000521971	1,122625659	0,291165448
Residual	141	0,065558717	0,000464955		
Total	142	0,066080688			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,045755951	0,002165516	21,12935596	1,55855E-45
GPR Fin	0,021733512	0,020512209	1,059540306	0,291165448

Figure 13 Regression statistics between Finland's GPR and the OMXH25 index.

The set of data for Finland gives results that are not good enough considering the aims of our study. With the first look on R square (0,007), which would indicate that the model if he was any good would only explain 0,7% of the data. The significance of F is at 0,291 which is much greater than Alpha (0,1). At the 10% confidence level, we are unable to reject the null hypothesis meaning that there is no significant relation between Finland’s GPR and the OMXH25 volatility. Additionally, the P-value that illustrates the relevance of the coefficient is also much greater than Alpha with a value of 0,291 too. Therefore, the coefficient is not relevant either. This confirms the intuition that the study for Finland would not bring much.

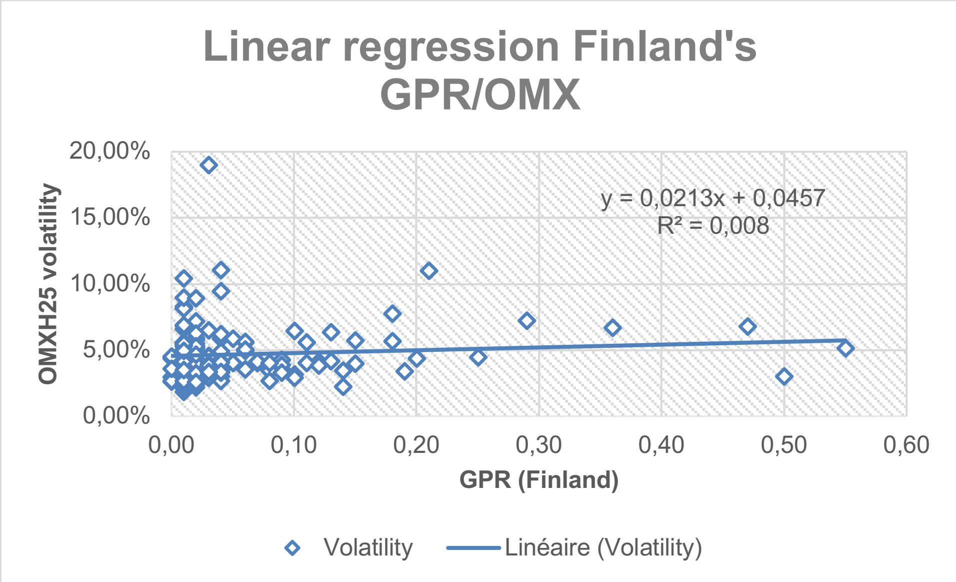

Figure 14 Graph presenting the linear regression between Finland's GPR and the OMXH25 index's volatility.

This scatter plot representing the relation between OMXH25's volatility and Finland's GPR presents clearly a phenomenon on that data set. Overall, the OMXH25's volatility stays relatively low across time, so does Finland's GPR which is not ideal at all for any sort of linear regression study.

5.1.2 Relation between Russia's GPR and OMXH25 index

Regression Statistics	
Multiple R	0,121972417
R Square	0,014877271
Adjusted R Square	0,007890584
Standard Error	0,021486857
Observations	143

ANALYSE DE VARIANCE

	df	*SS*	*MS*	*F*	*Significance F*
Régression	1	0,0009831	0,0009831	2,129374421	0,146723949
Résidus	141	0,065097588	0,000461685		
Total	142	0,066080688			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,043746795	0,002877518	15,2029597	1,63727E-31
GPR Rus	0,002580899	0,001768662	1,459237616	0,146723949

Figure 15 Regression statistics between Russia's GPR and the OMXH25 index.

Overall, the result here does not seem much better than for Finland. If the model would be relevant to 1,4% of the data with an R Square of 0,014. The Significance of F (0,147) as well as the P-value (0,147) are greater than Alpha 0,1. This induces that neither the model nor the coefficient can be considered acceptable results. Therefore, at the 10% confidence level we are unable to reject the null hypothesis meaning that there is no significant relation between Russia's GPR and the OMXH25 volatility.

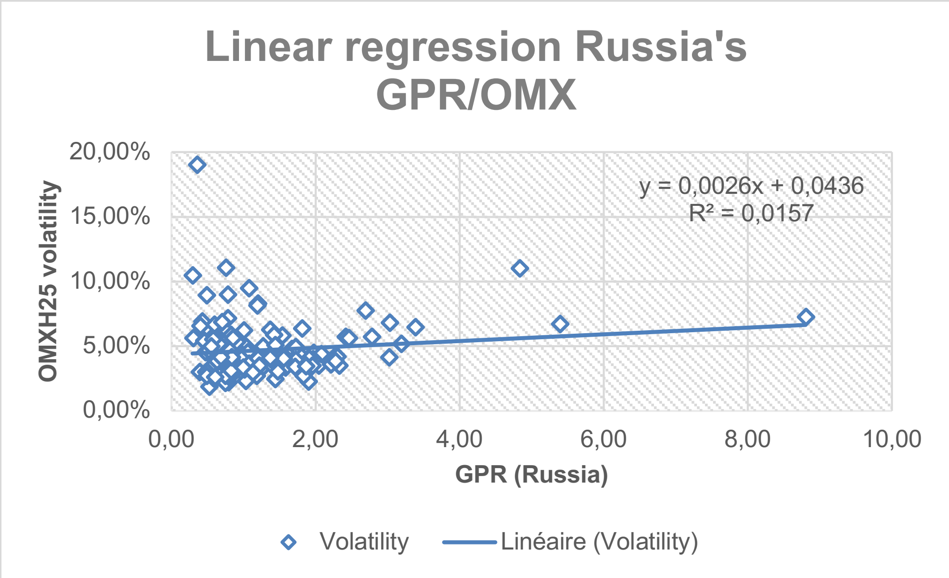

Figure 16 Graph presenting the linear regression between Russia's GPR and the OMXH25 index's volatility.

Looking at this graph helps to understand that with an overall greater GPR, the line seams slightly more relevant. Though an important quantity of points diverges, and no visible alternative trend can be clearly identified.

5.1.3 Relation between Ukraine's GPR and OMXH25 index

Regression Statistics	
Multiple R	0,142819072
R Square	0,020397287
Adjusted R Square	0,01344975
Standard Error	0,021426573
Observations	143

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	0,001347867	0,001347867	2,935901949	0,088827984
Residual	141	0,064732821	0,000459098		
Total	142	0,066080688			

	Coefficients	*Standard Error*	*t Stat*	*P-value*
Intercept	0,044915322	0,002174544	20,65505539	1,76132E-44
GPR Ukr	0,002655689	0,00154991	1,713447387	0,088827984

Figure 17 Regression statistics between Ukraine's GPR and the OMXH25 index.

The model based on the Ukrainian GPR is much more interesting for the study that could be the one Russia or Finland. Here we have a Significance F of 0,089. As this result, is smaller than alpha (0,1), at the 10% confidence level we are able to reject the null hypothesis meaning that there is a significant relation between Ukraine's GPR and the OMXH25 volatility. It's though important to acknowledge that the model would not be considered as a significant one at the 5% and 1% confidence level (with an alpha of 0,05 or 0,01). The same thing can be observed regarding the P-value (0,089). This makes the coefficient of 0,003 significant even if it stays small and lead us to assume a relatively flat model. R square (0,020) allows us to understand that the model is relevant for 2% of the value it features.

If those results are encouraging, it's still important to note that it does not allow to establish a powerful link. Not necessarily surprising given the parameter of the study it's encouraging to seek for better results in similar study with different parameters.

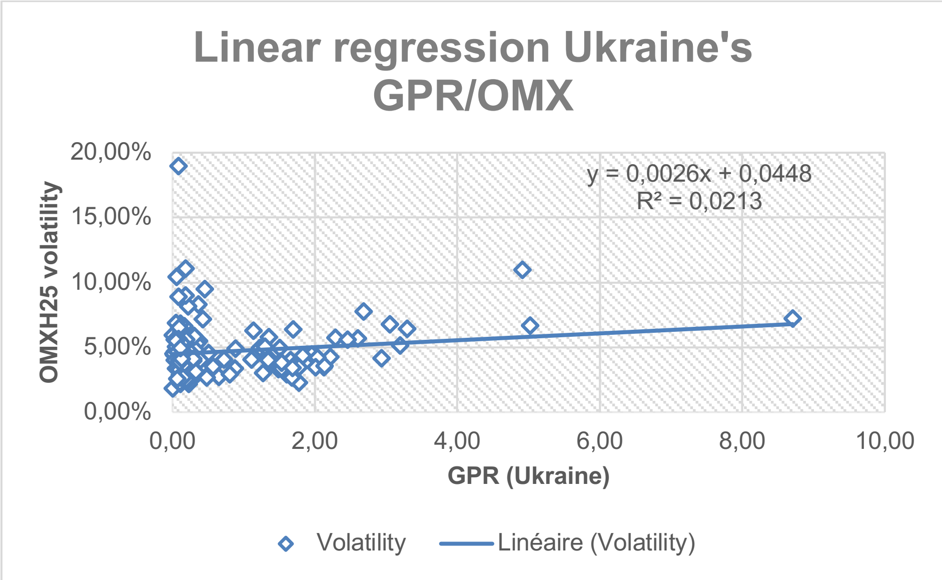

Figure 18 Graph presenting the linear regression between Ukraine's GPR and the OMXH25 index’s volatility.

This graph, also visually better that the two previous one gives the idea that by removing the occurrence on the data set that is clearly linked to another sort of risk it could give much greater results.

5.2 Discussion of the results

In the previous part (5.1), is introduced the result of the linear regression study for the GPR of Finland, Russia and Ukraine. Primarily, no evident relation is observed on the studied period when it comes to Finland’s and Russia’s GPR study. However, we have accepted the weak relation discovered for Ukraine’s GPR as relevant.

The idea that the OMXH25 index is better related to the Ukrainian GPR than the two others can appear logic. Primarily the small variation and small absolute value of the GPR for Finland that don’t offer much to work with. This is completely related to the “peaceful” situation in Finland compared to the two others.

Secondly, as discussed earlier (4.3), Russian and Ukraine GPR the two index are well related across the studied period. The fact that the linear regression result is greater when it comes to Ukrainian GPR than the Russian GPR demonstrate a that the war between Ukraine is Russia is a more important geopolitical risk for investors in the Finnish market than other Russian action in the period. Russia’s other action in Syria, Georgia, Africa as well as their participation in international institution such as BRICS does not impact the Finnish stock exchange as much as the war in Ukraine.

Thirdly, in the studied period [April 2013; February 2025] the Russo-Ukrainian war is likely to have been the main geopolitical event perceived from Finland. It would therefore be interesting to study the link between the OMXH25 index and GPR of other active region in the period such as Syria, Israel, Iran, Yemen, China… to see how they influence the investor behaviour towards Finland's market.

While acknowledging all the limitation of those results and that it would not support the idea that we can establish any sort of strong relationships in the parameter of our study, those results stay very encouraging for further research.

6 Conclusion

If the results of this study are not as good as it could have been expected before the analyses, they are still encouraging to continue to investigate the relation between geopolitical risk and financial market. The result obtained regarding the link between Ukrainian GPR and the OMXH25 index, leads us to think that event around the Baltics might not be as impacting on the stock traded in Helsinki than major events in the rest of the world.

It can be assumed that major events in the Baltic Sea would have an impact on Helsinki stock exchange greater than would if an event of the same magnitude appended somewhere else. Though, massive event such as war mobilising international support (Ukraine) or impacting the international logistics (Red Sea) are likely to have much more impact on markets across the world.

This opens to what would be relevant complementary study. This research, was only conducted using the OMXH25 index as a base for financial data, with the problem that data are collectable only from April 2013 forward. (Yahoo Finance, 2025) This removes the possibility to study how the market reacts to other major historical events. Developing the study on broader financial data set would help to understand those relations as well as identify if certain type of index, capitalization, industry reacts more to geopolitical risk.

On the geopolitical risk aspect, it has been constrained by the complexity of such study and the fact that they would require much more recourses. Identifying ties between geopolitical event and market on brother geographic parameter could be extremely relevant.

Additionally, the experiment identified that stock market is subject to various kinds of risk but that certain change in volatility can clearly be imputed to some geopolitical major event. Running a more detailed study that would aim to tie GPR of country where those events took place with market on specific time would be interesting to try to isolate geopolitical risk among the factors that influence financial market volatility.

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Appendix 1 : Data collection code

Program allowing to download the mensal value of the companies:

```
import yfinance as yf

import pandas as pd

symbols = [ "NDA-FI.HE", "KNEBV.HE", "NOKIA.HE", "ERIBR.HE",
"SAMPO.HE", "UPM.HE", "FORTUM.HE", "TELIA1.HE", "WRT1V.HE",
"METSO.HE", "STEAV.HE", "STERV.HE", "ORNAV.HE", "ORNBV.HE",
"KESKOA.HE", "KESKOB.HE", "ELISA.HE", "NESTE.HE", "SSABAH.HE",
"SSABBH.HE", "KCR.HE", "VALMT.HE", "HUH1V.HE", "KEMIRA.HE",
"CGCBV.HE", "MANTA.HE", "TIETO.HE", "KALMAR.HE", "KOJAMO.HE",
"QTCOM.HE", "VAIAS.HE", "OUT1V.HE", "TTALO.HE", "SANOMA.HE",
"METSA.HE", "METSB.HE", "FSKRS.HE", "ALMA.HE", "PUUILO.HE",
"TYRES.HE", "HARVIA.HE", "AKTIA.HE", "FIA1S.HE", "PON1V.HE",
"TOKMAN.HE", "OLVAS.HE", "MUSTI.HE", "KEMPOWR.HE", "REG1V.HE",
"ALBAV.HE", "ALBBV.HE", "SCANFL.HE", "CTY1S.HE", "YIT.HE",
"MEKKO.HE", "EVLI.HE", "LINDEX.HE", "TALLINK.HE", "EQV1V.HE",
"CANATU.HE", "VIK1V.HE", "ENENTO.HE", "RAIKV.HE", "RAIVV.HE",
"LAT1V.HE", "CAPMAN.HE", "ATRAV.HE", "GOFORE.HE", "ICP1V.HE",
"OMASP.HE", "PIHLIS.HE", "ETTE.HE", "BITTI.HE", "FSECURE.HE",
"RELAIS.HE", "ANORA.HE", "DETEC.HE", "TAALA.HE", "FARON.HE",
"OKDAV.HE", "OKDBV.HE", "NOHO.HE", "UNITED.HE", "REMEDY.HE",
"DIGIA.HE", "HEALTH.HE", "KOSKI.HE", "WITH.HE", "PAMPALO.HE",
"ASPO.HE", "TNOM.HE", "SUY1V.HE", "SFOODS.HE", "LEMON.HE",
"AIFORIA.HE", "KAMUX.HE", "HKFOODS.HE", "ALEX.HE", "NANOFH.HE",
"RAUTE.HE", "ILKKA2.HE", "ORTHEX.HE", "TITAN.HE", "SITOWS.HE",
"APETIT.HE", "SRV1V.HE", "VERK.HE", "NLG1V.HE", "CONSTI.HE",
"AFAGR.HE", "KSL.HE", "OPTOMED.HE", "ASUNTO.HE", "KREATE.HE",
"LOIHDE.HE", "VIAFIN.HE", "LAPWALL.HE", "GLA1V.HE", "IFA1V.HE",
"MERIH.HE", "RAP1V.HE", "FODELIA.HE", "NXTMH.HE", "TOIVO.HE",
"BRETEC.HE", "TEM1V.HE", "TLT1V.HE", "MODU.HE", "SIILI.HE",
"SSH1V.HE", "SPRING.HE", "BIOBV.HE", "MERUS.HE", "DWF.HE",
"AALLON.HE", "TAMTRON.HE", "EXL1V.HE", "WETTERI.HE", "ESENSE.HE",
"CTH1V.HE", "LAMOR.HE", "LEADD.HE", "SAGCV.HE", "PARTNE1.HE",
"INVEST.HE", "INDERES.HE", "DUELL.HE", "ADMIN.HE", "ROBIT.HE",
"ACG1V.HE", "BOREO.HE", "VINCIT.HE", "NETUM.HE", "HEEROS.HE",
"ALISA.HE", "TULAV.HE", "HRTIS.HE", "KHG.HE", "SOSI1.HE", "OVARO.HE",
"REKA.HE", "DOV1V.HE", "SOLWERS.HE", "SPINN.HE", "WITTED.HE",
"EEZY.HE", "QPR1V.HE", "WUF1V.HE", "FONDIA.HE", "ECOUP.HE",
"PNA1V.HE", "FIFAX.HE", "REBL.HE", "EAGLE.HE", "BETOLAR.HE",
"HONBS.HE", "NORRH.HE", "KELAS.HE", "SOLTEQ.HE", "ELEAV.HE",
"DIGIGR.HE", "TRH1V.HE", "MARAS.HE", "PALLAS.HE", "PIIPPO.HE",
"RUSH.HE"]

start_date = "1985-01-01"
```

```
end_date = "2025-02-28"

data = {}

for symbol in symbols:

    data[symbol] = yf.download(symbol, start=start_date, end=end_date,
interval="1mo")["Close"]

df = pd.concat(data, axis=1, keys=symbols)
```

Program allowing to download the daily data for the indexes.

```
import yfinance as yf
import pandas as pd

symbols = [ "^OMXH25", "^OMXHLCGI", "^OMXHMCGI", "^OMXHSCGI"]

start_date = "1985-01-01"
end_date = "2025-02-28"

data = {}
for symbol in symbols:
    data[symbol] = yf.download(symbol, start=start_date, end=end_date)["Close"]

df = pd.concat(data, axis=1, keys=symbols)

print(df.head())
```