TERROR ATTACKS AND EXCHANGE RATES: EMPIRICAL EVIDENCE FROM DEVELOPED AND EMERGING COUNTRIES

Jyväskylä University
School of Business and Economics

Master's Thesis

2023

Author: Oona Jauhiainen
Subject: Banking and International Finance
Supervisors: Heikki Lehkonen and Kari Heimonen

JYVÄSKYLÄN YLIOPISTO
UNIVERSITY OF JYVÄSKYLÄ

ABSTRACT

Author
Oona Jauhiainen

Title
Terror attacks and exchange rates: empirical evidence from developed and emerging countries

Subject	Type of work
Banking and International Finance	Master's thesis
Date	Number of pages
21.04.2023	65

Abstract

Terrorism and terror attacks form a rising threat to the economy and financial markets, while the research area related to terrorism and foreign exchange markets still remain limited. Investigating terror attacks and exchange rates is essential due to the fundamental position of exchange rates in every international trade. In addition, exchange rates play an important part in pricing international financial instruments, such as derivatives. The aim of this thesis is to investigate the relationship between terrorism and exchange rates from three different viewpoints: geopolitical risk in terms of terrorism and its effect to uncovered interest rate parity (UIP) deviation, cumulative abnormal returns (CAR), and explanatory variables of CAR.

By investigating terror attacks, geopolitical risk indices, and a set of exchange rates with linear regression models and event study methodology, this thesis shows that terrorism can cause different effects among developed and emerging countries. In addition, the empirical results indicate that currency pairs from emerging countries are generally more affected by terror attacks causing statistically significant results. Furthermore, the results show that an increase in geopolitical risk leads to a significant increase in UIP deviation as well as local currency risk premiums among selected emerging countries.

This thesis obtains new evidence of how UIP deviation is affected by geopolitical tensions in terms of terrorism in emerging countries. Information can be valuable for investors and other market participants. In addition, the results highlight that also in the future terrorism will play an important part in geopolitical risks that should be considered when making financial decisions.

Key words
Terror attack, exchange rate, developed countries, BRICS, geopolitical risk index, UIP

Place of storage
Jyväskylä University Library

TIIVISTELMÄ (ABSTRACT IN FINNISH)

Tekijä
Oona Jauhiainen

Työn nimi
Terrori-iskut ja valuuttakurssit: empiirisiä tuloksia kehittyneistä ja kehittyvistä maista

Oppiaine	Työn laji
Banking and International Finance	Pro Gradu- tutkielma
Päivämäärä 21.4.2023	Sivumäärä 65

Tiivistelmä

Terrorismi sekä terrori-iskut luovat taloudelle sekä rahoitusmarkkinoille nousevan uhan, mutta tästä huolimatta niiden vaikutuksista valuuttakurssimarkkinoihin tiedetään vain vähän. Terrori-iskujen sekä valuuttakurssien tutkiminen on erityisen tärkeää valuuttakurssien fundamentaalisen roolin vuoksi: esimerkiksi valuuttakurssilla on oma roolinsa jokaisessa kansainvälisessä rahasiirrossa. Lisäksi valuuttakurssit vaikuttavat esimerkiksi erilaisten rahoitusinstrumenttien hinnoitteluun, kuten johdannaisiin. Tämän pro gradu-tutkielman tarkoituksena on tutkia terrorismia sekä valittuja valuuttakursseja kolmesta eri näkökulmasta: geopoliittinen riski-indeksi terrorismin mittarina ja sen vaikutus kattamattoman korkopariteetin (UIP) poikkeamaan, kumulatiivisia ylituottoja (CAR) sekä kumulatiivisten ylituottojen selittäviä tekijöitä.

Tutkimalla terrori-iskuja, geopoliittisia riski-indeksejä sekä valittuja valuuttakursseja lineaarisen regression ja tapahtumatutkimuksen avulla, tämä tutkielma osoittaa, että terrori-iskut voivat vaikuttaa eritavoin kehittyneisiin ja kehittyviin maihin. Lisäksi empiiriset tulokset näyttävät, että kehittyvien maiden valuuttakurssit reagoivat herkemmin terrori-iskuihin. Tulokset myös näyttävät, että geopoliittisen riskin kasvu lisää UIP poikkeamia sekä valuuttariskipreemioita kehittyvien maiden joukossa.

Tämä tutkielma tuottaa uutta tietoa siihen, miten geopoliittiset jännitteet liittyen terrorismiin vaikuttavat kattamattoman korkopariteetin poikkeamaan kehittyvissä maissa. Tällä tutkielmalla saavutettu tieto on arvokasta sekä sijoittajille, että muille markkinoilla toimiville. Lisäksi tulokset korostavat, että on tärkeää tutkia terrori-iskujen vaikutusta yhtenä geopoliittisena riskinä valuuttamarkkinoihin liittyen myös tulevaisuudessa.

Asiasanat
Terrori-isku, valuuttakurssi, kehittyneet maat, BRICS, geopoliittinen riski-indeksi, kattamaton korkopariteetti

Säilytyspaikka
Jyväskylän Yliopiston Kirjasto

CONTENTS

LIST OF TABLES AND FIGURES

List of tables:

List of figures:

1 INTRODUCTION

According to Europol (2022) terrorism can be considered as one of the main threats inside Europe. Already Hoffman (2006) stated that terrorism can be specified to be violent actions against national security with the means of political, social, environmental, and economical purposes. Even if conflicts as wars, and their effects on the economy have been studied relatively lot, terrorism on the other hand has been a minor study area (Bloomberg et al., 2004; Balcilar et al., 2017). Terrorism and its effects on the economy and financial markets can thus be seen as a relatively new research area, but after the catastrophic terror attack of 11th of September in 2001 (later also referred as 9/11) the effect on economy has awakened concerns and importance in research. Furthermore, recent empirical evidence shows that foreign exchange markets are reactive to shocking events (Sharma et al., 2019).

Terror attacks and terrorism are interesting research objectives themselves, but even more, their possible devastating consequences make it an important research area in the financial sector. Within the last 20 years, terror attacks have been in the media more often. For example, terror attacks in Paris and in Nice evoked concerns as being popular tourist attractions. Terror attacks increase additional country and geopolitical risks, but also, can affect the economy as whole. Terror attacks, when taking place, can be seen as actions which destabilize the whole economy. Terror attacks and terrorism affect the country directly, but additionally indirect effects can be obtained. Some research claims that terror attacks can affect corporate investments, consumers consumption, and even the GDP of the country (Bloomberg et al., 2004). On the other hand, large terror attacks can negatively affect the attraction of the country. Gunasekar et al. (2018) more particularly found that in case of large terror attack in India November 2008, the number of tourists significantly decreased. Thus, the effects go far, even crossing national borders.

Exchange rate, as other research objective of this thesis, is a macroeconomic fundamental which on its own behalf plays an important role in financial decision making domestically and internationally. Balcilar et al. (2017) highlight in their paper that currency markets are the largest and one of the most liquid

markets, which makes the area an important research topic. On the other hand, due to high integration of the markets and contagion effects, terror attacks can have a large effect internationally on the currency markets. The high integration level can also be seen among the foreign exchange markets, which indicates terror attacks may have a large influence both on short- and long-term exchange rates.

1.1 Motivation for the research

This master's thesis aims to describe the relationship between terror attacks during the years 2000-2020 and exchange rates in selected countries against the US dollar. Terror attacks are catastrophic events which can have short-and long-term effects to peoples' lives and economy. For instance, Nilsen et al. (2018) presented in their research that in case of the Norway attacks in 2011, the attacks led to several different kinds of security related plans as well as granting larger share of resources for general safety in Norway. In addition, previous research shows that disasters affect market participants' mood creating anxiety and uncertainty (Kaplanski and Levy, 2010).

Exchange rates as well as currency markets create the fundamental base for every trade and capital flow. Exchange rates also play a crucial role in pricing financial instruments, for example derivatives. However, financial markets, including stock as well as bond markets have been widely studied related to terror attacks, but foreign currency markets have been a minor study area. Balcilar et al. (2017) highlight that exchange rates and terror attacks are a narrow study area as well as the empirical evidence remains small between the relationship of these two objectives. This emphasizes the research interest among foreign exchange markets and terror attacks. According to the Survey of Global Foreign Exchange Market Volumes conducted by Bank of International Settlements (BIS) the size of the foreign exchange market was around 6,6 trillion US dollars daily in 2019 (Bank of International Settlements, 2022). In April 2022, the same figure was already 7,5 trillion US dollars (Bank of International Settlements, 2022). This indicates the substantial as well as growing scale of the market, and on the other hand, the international importance of the foreign exchange market.

The previous empirical evidence related to terror attacks and exchange rates is controversial. In most research the connection between terror attacks and selected exchange rates is found (Hassapis et al., 2018; Maitah et al., 2017; Balcilar et al., 2017). However, some research also highlights that the effect of terror attacks is not long lasting, nor statistically significant (Markoulis, 2021). Even if the research objectives itself of this thesis have been studied before, the viewpoint differs and is unique. The combination of an interesting data set of emerging and developed countries as well as corresponding terror attacks create a unique base for the thesis and hopefully, reveal unseen results about the behavior of exchange rates in case of terror attacks. Previous research uses efficient market hypothesis

as theoretical base and thus, event study methodology as a starting point to investigate the terror attacks and exchange rates in many cases. However, in this thesis the aim is to widen this perspective with the fundamental theory of short-term exchange rates, uncovered interest rate parity (UIP). The deviation in the equation is often called the currency risk premium (Zhou et al., 2021; Farhi & Gabaix, 2016). Zhou et al. (2021) as well as Farhi and Gabaix (2016) indicate that this currency risk premium can be influenced by rare disasters.

Gupta et al. (2019) found in their research paper that rare disasters have predictive power to the returns and volatilities of exchange rates. Moreover, Zhou et al. (2021) also investigated Covid-19 as a rare disaster and its effect on exchange rates and macroeconomic policies. Similarly, they also found that this rare disaster affected exchange returns and more importantly, the effects were seen controversial between advanced and emerging countries (Zhou et al., 2021). These controversial results indicate possible safe-haven currencies and international capital flows, which were also confirmed by Farhi and Gabaix (2016). This is why this thesis furthermore concentrates on differences between developed and emerging countries. The emerging market area forms an interesting and all the time growing, unique research area in addition to selected developed countries.

Even if rare disasters have been investigated from many perspectives including Covid-19, wars, political crises, and natural catastrophes, terror attacks as rare disasters in this specific framework have not been studied before and therefore it offers a gap in existing research. Because there is no specific index for terror attacks or threat of terrorism that could be used in this thesis, geopolitical risk index with its three dimensions is used in empirical models of this thesis.

To some extent, this paper follows the viewpoint from research Zhou et al. (2021) related to rare disaster framework. Only the empirical results will show can the rare disaster term be used when talking about geopolitical risk in terms of terrorism and its effect on UIP deviation. The data set uniquely combines different countries from different economic perspectives thus creating a research opportunity to complement the previous empirical evidence.

To further investigate the relationship between terror attacks and exchange rates, a set of developed and emerging countries are selected. Developed countries selected for the investigation are Switzerland, Norway, United Kingdom, and France. All the countries are in Europe to narrow the data sample. This also gives the opportunity to investigate possible spillover effects between countries and currency pairs. Moreover, also two large terror attacks from United States are included to the sample due to possible spillover effects. Corresponding currencies that will be used against the US dollar are Swiss franc, Norwegian krone, Pound sterling, and Euro. Moreover, during the past twenty years major terror attacks have taken place in the selected countries causing a lot of media attention and uncertainty among market participants. Moreover, the Europol (2022) indicates that terrorism is still one of the largest threats in the European Union.

For achieving a unique database and unique information related to emerging countries, this paper additionally investigates the BRICS (Brazil, Russia, India, China, and South Africa) countries. However, to really see the effects of the terror attacks, only floating exchange rates are used in estimations. Due to this, China has been left out of the sample because of its pegged exchange rate. Again, all the exchange rates are studied against the US dollar. Corresponding currencies are Brazil real, Russian ruble, Indian rupee, and South African rand. Given the essential role of the BRICS countries for world economy, it is important and interesting to study how the exchange rates are affected by terror attacks in these countries. The term BRIC was first introduced in 2001 whereas South Africa was added to the list in 2010 (Iqbal, 2022). Moreover, BRICS is an essential part of the global economy: Iqbal (2022) states that BRICS covers important aspects of world population (40 %), GDP (25 %), and world trade (18 %). In addition to that, BRICS is involved in global forex with 4 USD trillion (Iqbal, 2022). According to the International Monetary Fund (2021), in emerging and developing Asia the real GDP growth in 2022 is 6 percent and for 2023 the prediction is 8.6 percent. In line with this, it can be concluded that BRICS plays an important role in the world economy and more importantly, plays a crucial role also in foreign exchange markets.

1.2 Research questions

The two research objectives of this thesis, terror attacks and selection of exchange rates, aim to investigate the relationship between those objectives. Furthermore, this aim is investigated from three different perspectives. First, the aim is to reveal the relationship between geopolitical risk indices and UIP deviation. Second, with event study methodology, the possible abnormal and cumulative abnormal returns in case of specific terror attacks are investigated. Third, selection of explanatory variables related to terror attacks as well as other related variables are investigated aiming to show how different kinds of terror attacks affect exchange rates' abnormal returns.

To investigate the above-mentioned aims, the author has formed one main research question. The main research question of this thesis is as following:

1. *How do terror attacks affect exchange rates in selected developed and emerging countries?*

To investigate this question more deeply, three sub-questions are formed as following:

A. *How geopolitical risk indices in terms of terrorism affect the UIP deviation?*
B. *Do selected terror attacks generate abnormal or cumulative abnormal returns?*
C. *Which explanatory variables affect cumulative abnormal returns?*

The hypotheses for the emerging and developed countries have also been formed separately and are introduced in section 4.1.

1.3 Structure of the thesis

This thesis is built on a theoretical framework connecting the terror attacks to exchange rates while reviewing the previous literature. The structure of this thesis will be built in the following way. Chapter 1 introduces the research objectives and the motivation for this thesis. The chapter 2 establish the theoretical framework for the paper which can be divided into two separate parts: uncovered interest rate parity as fundamental presentation of short-term exchange rates and two different channels between terror attacks and exchange rates: macroeconomy and market participants. Chapter 3 introduces the different definitions of terrorism, geopolitical risk index, previous literature related to terrorism, financial markets, and economy as well as shortly the context of rare disasters.

After that chapter 4 describes the data, presents the chosen terror attacks with their characteristics, as well as specifies the models of the empirical part. The following is chapter 5, where the results and discussion are given with corresponding figures and graphs related to empirical results. Last, chapter 6 gives the conclusion and captures the main ideas from the results and analysis. In addition, suggestions for future research as well as limitations of this thesis are discussed.

2 THEORETICAL FRAMEWORK

This chapter introduces a theoretical framework for the thesis. The importance of the theoretical framework is crucial due to it will create the base for the whole thesis. The theoretical framework starts with determining the short-term exchange rate by explaining the uncovered interest rate parity (UIP) and possible deviation which can be said to be a currency risk premium (Zhou et al., 2021). Furthermore, two channels between terror attacks and exchange rates are introduced and connected to the determination of exchange rate. In addition to UIP and channels, as most of the research in finance, also in this thesis it is assumed that the markets function efficiently according to the efficient market hypothesis.

2.1 Determination of short-term exchange rate

Different kinds of models related to exchange rates and rare disasters have been proposed and formed by many researchers (see e.g., Rietz, 1988; Barro, 2006; Berkman et al., 2011; Farhi & Gabaix, 2016). Moreover, the research area can be seen as full of opportunities since rare and extreme disasters can be one explanation for asset-pricing puzzles (Berkman et al., 2011). According to Farhi and Gabaix (2016), rare and extreme disasters can be kept as one of the main determinants for the risk premia in asset markets. Addition to that, Berkman et al. (2011) investigated time-varying disaster probability models on stock markets and found that the more extreme the disaster is the more it has market impact: these extremes also indicate higher disaster probability. Based on this, Farhi and Gabaix (2016) investigated and formed a new model. They suggest in their model that extreme disasters can happen at any point of time and that disasters are time-varying (Farhi & Gabaix, 2016). According to Farhi and Gabaix (2016), this time-varying effect in the disasters creates fluctuation for example to exchange rates in addition to other asset markets. This, on the other hand, can cause some currencies to depreciate and some currencies to appreciate. The model developed by Farhi and Gabaix (2016) also represents that the model is built on several puzzles related to exchange rates.

Zhou et al. (2021) define this deviation as currency risk premium in their research paper and investigate the effect with uncovered interest rate parity (UIP) which can be kept as a theoretical basis for the short-term exchange rates. Similarly, Rabitsch (2016) claims that deviation in UIP can be seen as a risk premium in the foreign exchange markets. This paper also follows Zhou et al. (2021) determination of UIP and UIP deviation: in this thesis, UIP deviation is treated as excess return.

UIP deviation is defined as following:

$$ExRet_{it} = i_{it} - i_{it}^{US} - (e_{it+1} - e_{it}) \quad (1)$$

where:

t = time
i = country
$ExRet_{it}$ = excess return (UIP deviation)
i_{it} = domestic short-term interest rate
i_{it}^{US} = US federal funds rate
e_{it} = exchange rate

UIP thus represents an equation where difference in domestic and US short-term interest rates equals change in that country's exchange rate (Zhou et al., 2021).

2.2 Channels between terror attacks and exchange rates

According to Balcilar et al. (2017) there can be seen two different channels how the terror attacks can affect the exchange rates: through macroeconomic fundamentals and through markets participants, for example investors. Moreover, the uncovered interest rate parity view shows the short-term effects of terror attacks but through these channels the attack can be seen in addition causing many long-term effects to the economy. In the case of terror attacks, there can be seen many long-term effects on macroeconomic level. Balcilar et al. (2017) present in the research that for example government spending, international trade flows and international capital flows change in case of a terror attack. Similarly, Eckstein and Tsiddon (2004) state that in case of a terror attack government spending especially increases due to increase in security costs. These findings are in line with other previous literature that terrorism causes direct but also indirect costs.

Moreover, what can be seen as an interesting macro fundamental effect is the effect on international capital flows. Enders et al. (2006) state that the international capital flows can be caused by terror attacks because terror attacks cause exchange rates to fluctuate. Moreover, Balcilar et al. (2017) continue that the fluctuations in capital are larger in countries where the markets are more integrated and countries where the terror attack threat is smaller. On the other hand, these capital flows can also create countries which can be kept as safe havens. Zhou et

al. (2021) found in their research that capital flows to safer countries where the risk is smaller: this also makes the assets safer, including currencies. Also, Farhi and Gabaix (2016) found that riskier currencies will depreciate in case of rare disaster while safer currencies (for example Swiss Franc) tend to appreciate. In line with this research, safe-haven currencies can be seen as an end-result in case of capital flows.

According to Balcilar et al. (2017) the market participant-channel can be seen as a more important channel between terror attacks and exchange rates. Furthermore, Kaplanski and Levy (2010) investigated aviation disasters as rare disasters and highlighted that disasters cause anxiety and uncertainty, which on the other hand cause instability of the financial markets. The second important part of this paper's theoretical framework will be built on market participants, especially investor behavior and sentiment. Naturally such drastic events as terror attacks affect investors' feelings and emotions.

Similarly, to Balcilar et al. (2017), Kaplanski and Levy (2010) emphasize the behavioral and investor point of view in their research. They indicate that in case of a disaster anxiety creates negative impacts on investors and this, on the other hand, can cause investors to act irrationally on the markets (Kaplanski and Levy, 2010). Moreover, other studies have found similar indications. Already Slovic (1987) states that the largest factor affecting people's risk seeing ability is affected by "dread risk" which can be described to be the risk which is out of control and has elements for catastrophic events. Terror attacks are expected to happen rarely, and people do not expect these attacks to happen in their everyday lives. Thus, terror attacks can also cause the dread risk.

Hasso et al. (2020) investigate terror attacks and their effect on investor behavior. The research shows that investors in the countries where the terror attacks take place are affected more as well as their risk aversion increases (Hasso et al., 2020). Wang and Young (2020) made similar findings related to increase in risk aversion, but in addition they found that risk aversion is mainly caused by increase in fear as emotional feeling and not for example fear of losing assets. Shahzad et al. (2021) also conclude that investor sentiment and exchange rates are related to each other.

As already mentioned in the beginning of the theoretical framework, this paper assumes that the financial markets work efficiently and react to new information immediately. The theory was developed by Fama (1970) and now, efficient market hypothesis plays an important and inalienable part in modern day finance research. In addition, one of the empirical methods of this thesis, event study, is based on the idea of efficient market hypothesis (Ullah et al., 2021).

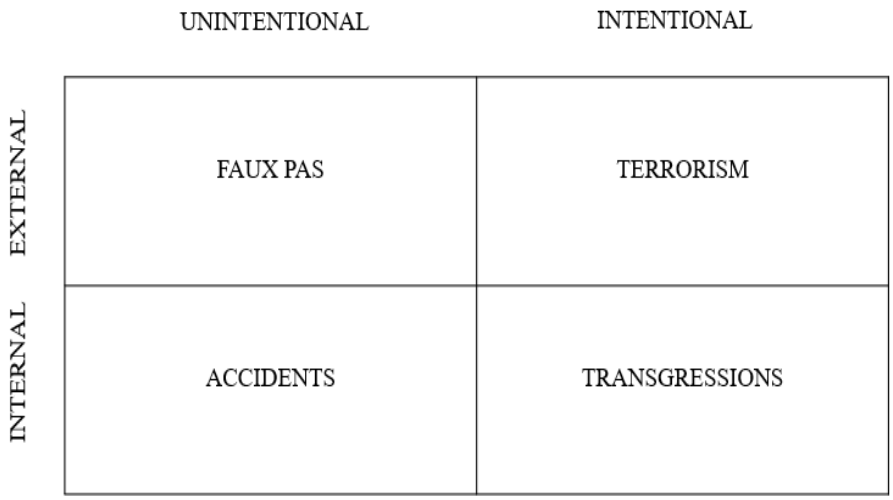
3 PREVIOUS LITERATURE

The previous literature chapter is divided into five parts. The first part introduces different classifications of terrorism as well as starts to describe terrorism in selected emerging and developed countries. Specific terror attacks are described in more detail in the next chapter 4.2. The second part discusses the geopolitical risk (GPR) index and its relationship to terrorism. The third and fourth part introduces large scale of previous literature related to terror attacks, economy, and financial markets. Last, previous literature related to rare disaster framework is shortly covered.

3.1 What is terrorism?

In addition to exchange rates and foreign exchange markets, this paper aims to investigate terrorism and terror attacks in selected emerging and developed countries. Terrorism is often seen as external conflicts with the possibility of catastrophic consequences: most of all, terrorism can be classified from several different viewpoints. The effects of terror attacks can be seen immediately after the attack, but, in addition, long-term effects are possible (see e.g., Lenain et al., 2002). In this thesis, the most common and known classifications of terrorism are presented in order to compile a viewpoint of terrorism. One of the most fundamental definitions of terrorism can be found from the crisis-type matrix by Coombs (1995). Figure 1 below explains the crisis model by external and internal factors as well as unintentional and intentional factors which companies can face (Coombs, 1995). According to the model, terrorism can be seen as an intentional act which comes from external source (Coombs, 1995).

Figure 1. Crisis-type matrix (Coombs, 1995).



Even if the definition of terrorism by Coombs (1995) is not, however, very broad and specific, it gives a good platform when the different aspects of terrorism are considered. This thesis also introduces other definitions of terrorism which differ from each other to some extent. An interesting way of dividing the terrorism into two categories is for example as following:

1. *International terrorism*: "Violent, criminal acts committed by individuals and/or groups who are inspired by, or associated with, designated foreign terrorist organizations or nations (state-sponsored)" (The Federal Bureau of Investigations, no date).

2. *Domestic terrorism*: "Violent, criminal acts committed by individuals and/or groups to further ideological goals stemming from domestic influences, such as those of a political, religious, social, racial, or environmental nature" (The Federal Bureau of Investigations, no date).

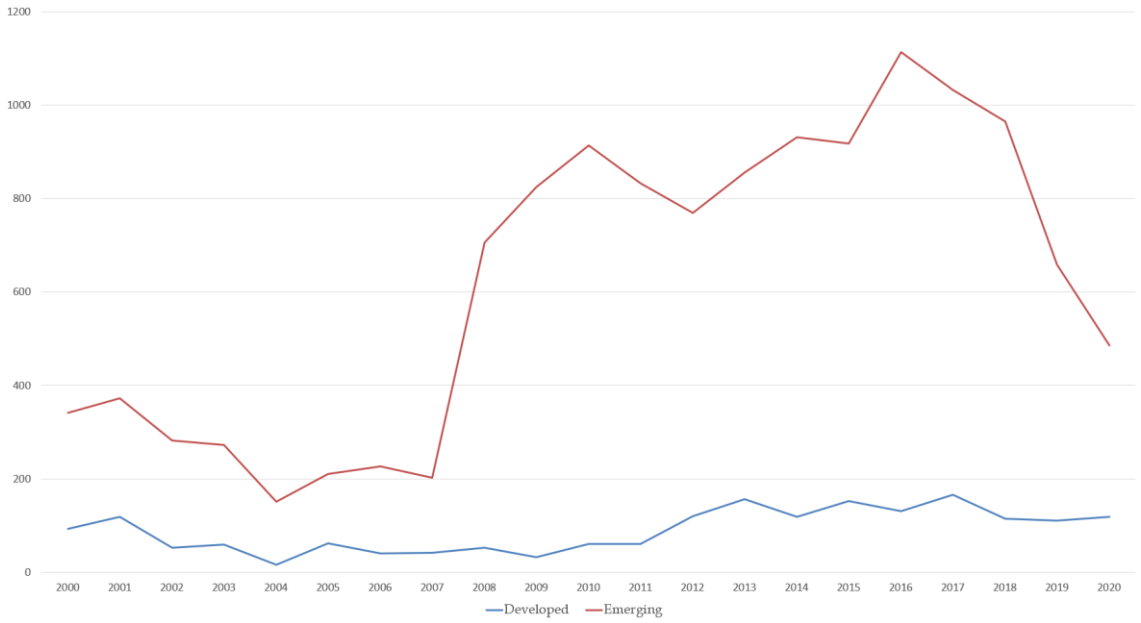
Every year, Europol compiles Terrorism Situation and Trend (TE-SAT) Report which gives a comprehensive picture of terror attacks and terrorism in European area (Europol, 2022). Europol (2022) divides terrorism into five different categories based on different ideologies and goals of attacks: jihadism, right-wing, left-wing and anarchist, ethno-nationalist, and separatist and other forms. The last category includes terror attacks that cannot be specified to be any other form (Europol, 2022). According to Europol (2022), jihadism terrorism has caused most arrests and attacks during the years 2019-2021. The second largest group is right-wing terrorism: however, the difference for example in the year 2021 between the attacks was eight (Europol, 2022). Below all the five groups by Europol (2022) report has been explained in more detail:

1. *Jihadism*: terror attacks are based on Sunni Muslim movement with the aim of building the Islamic State.
2. *Right-wing*: terror attacks are based on changing the whole political, economic, and social system while replacing them with violent authoritarianism and enhancing the group sharing common element, for example race.
3. *Left-wing and anarchist:* the meaning of terror attacks is to introduce socialism and societal model where the aim is classless society.
4. *Ethno-nationalist and separatist*: the meaning of terrorism is to create a state where, for example, nationalism can be admired.
5. *Other forms:* include for example single-issue terrorism which aims to attack on specific policy or practice.

All in all, history shows that some of the countries are more volatile in terms of terrorism than others. Global Terrorism Index (GTI) gathers a yearly report about the trends in terrorism (Global Terrorism Index, 2022). Report creates terrorism scores for countries all over the world (Global Terrorism Index, 2022). In the year 2021, Afghanistan had the highest score of terrorism: 9,109 out of 10 (Global Terrorism Index, 2022). Countries selected for this thesis score all below 5 out of 10 in the index excluding India which scores 7,432 (Global Terrorism Index, 2022). According to the Global Terrorism Index (2022) Islamic State, Al-Shabaab, Taliban and Jamaat Nusrat Al-Islam wal Muslimeen were the four deadliest terrorist groups during the year 2021. The Global Terrorism Index (2022) also indicates that terrorism may increase especially in the European area in the future due to ongoing conflicts in the Ukraine. This, on the other hand, increases the importance of this thesis.

Figure 2 below shows the amount of all terror attacks in selected developed countries and emerging countries. The selected developed countries include the United Kingdom, France, Norway, and Switzerland. Corresponding emerging countries are Brazil, Russia, India, and South Africa. Moreover, figure 2 enhances the importance of research related to terror attacks: the trend seems to be increasing between the years 2007 and 2016 among emerging countries. This enhances the fact that it is important to fill the research gap among emerging countries whether the exchange rates react to terror attacks in selected emerging countries and if they do, how large or long-lasting the impact is.

Figure 2. Amount of terror attacks during the years 2000-2020 in selected developed and emerging countries. (Source: Global Terrorism Database, 2022)



All in all, figure 2 highlights the importance of knowing the effects of terror attacks relative to the economy in these countries. Among selected developed countries the trend is upward sloping for the period 2000-2020. In the case of selected emerging countries, after the highest peak in 2016-2017, the amount of terror attacks has been decreasing. However, it is interesting to notice that the amount of terror attacks in selected developed countries is significantly less than in selected emerging countries. The substantial difference in the amount of terror attacks between selected emerging and developed countries can be explained by different economic, political, and social factors that differ between emerging and developed countries. Furthermore, Mnasri and Nechi (2016) highlighted that the political environment can boost or control the effects of terror attacks and thus the right governmental policies are crucial to control the effect of attacks. In addition, Javaid, and Kousar (2018) investigated terrorism and exchange rates in the light of political systems and highlighted that democracy as well as governmental policies affect exchange rate fluctuations.

3.2 Geopolitical risk indices

No universal terrorism index exists on daily level. Global Terrorism index (2022) indicates only yearly values and thus, for this thesis it can be seen not suitable for the estimations. As a consequence, the geopolitical risk (GPR) index within its three forms is used to measure the geopolitical risk in terms of terrorism. Geopolitical risk can be defined as danger, recognition or/and amplification of threat

which usually can be seen associating with wars, terrorism, or other conflicts (Caldara and Iacoviello, 2022a). Caldara and Iacoviello (2022a) built the GPR index based on three different stages: definition, measurement, and validation. The definition of GPR index is versatile but also prior to this thesis: Caldara, and Iacoviello (2022a) included terrorism also to their definition of the index. According to Caldara and Iacoviello (2022a) recent political tensions are often caused by terrorism: thus, it is inevitably a part of the geopolitical risks in the modern-day world. Due to this, Caldara, and Iacoviello (2022a) have also increased the percentage part of terrorism in the GPR index. Based on this, GPR indices can be seen as suitable variables for this thesis to investigate the UIP deviation and currency risk premiums.

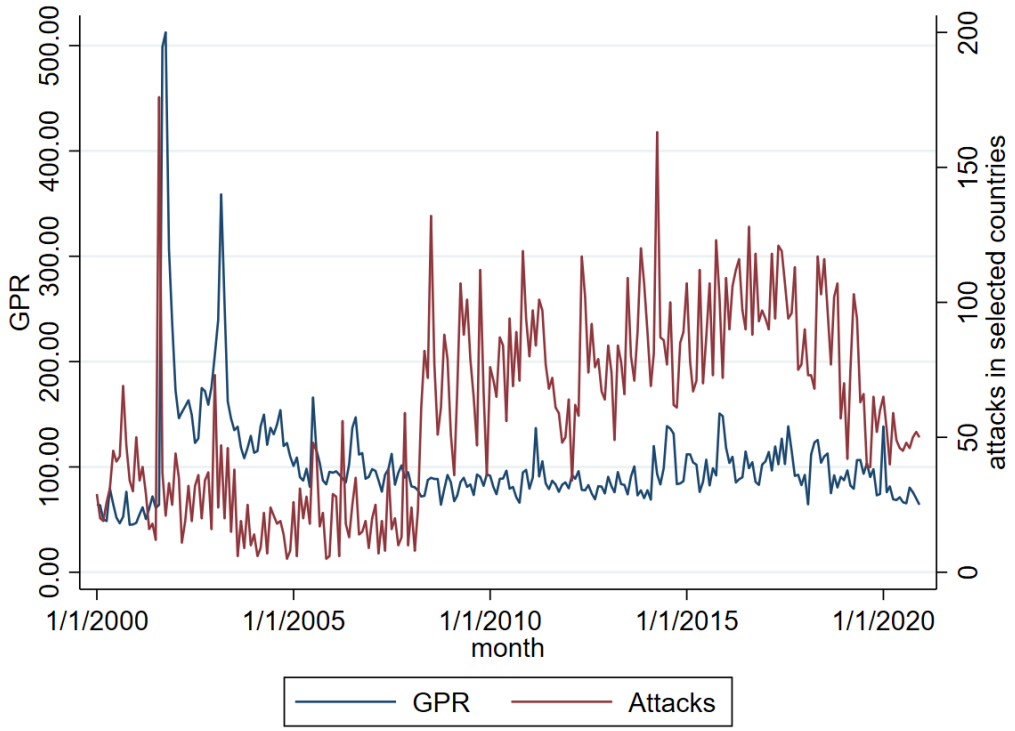
Moreover, GPR index can be seen massively hiking in case of wars but additionally also in case of September 11th (Caldara and Iacoviello, 2022a). According to graph combined by Caldara and Iacoviello (2022a), it can be clearly seen that the 9/11 caused massive peak in the index, larger than Gulf or Iraq war. In addition, terror attack in Paris in 2015 also increased the index (Caldara and Iacoviello, 2022a). The attack in Paris, 2015 as well as 9/11 are both included to the selected terror attacks of this thesis.

Caldara and Iacoviello (2022a) used dictionary-based method when measuring the geopolitical risk: method is used to gather information of specific war and other geopolitical risk related terminology from online. For instance, searched words included "terror" as well as "terrorism" (Caldara and Iacoviello, 2022a). Important matter related to GPR index that Caldara and Iacoviello (2022a) highlight was that the fear or threat of geopolitical tension may have more effect than the invasions or attacks itself. Moreover, in case of terror attack it can, however, increase the threat of new attack (Caldara and Iacoviello, 2022a). GPR index considers the threat as well as attacks that took place (Caldara and Iacoviello, 2022a). Therefore, also in this thesis these three different GPR indices are tested separately to see does the effect differ: general GPR index, GPR index with threat and GPR index with occurred attack events.

Figure 3 below presents the general GPR index as well as shows the amount of terror attacks in selected eight countries. Higher peaks can be distinguished from the GPR index. 9/11 triggered the index to increase extensively. On the other hand, also Iraq's war which started on 2003 caused an increase to the index. The amount of the terror attacks in selected countries seems to also follow the GPR index to some extent. However, between years 2005 and 2010 substantial increase can be seen in the amount of terror attacks. Ever since the amount of terror attacks has been higher than the first twenty years.

Previous empirical evidence concludes that GPR threat index can affect to stock returns especially during economy growth (Ma et al., 2022). However, the currency markets have been minor research are also what comes to relationship between GPR indices. Especially, the previous empirical evidence related to stock markets awake interest does the GPR index affect to abnormal returns that drastic events, such as terror attacks cause to exchange rates.

Figure 3. Geopolitical risk index and amount of terror attacks in selected developed and emerging countries. (Sources: Global Terrorism Database (2022) and Caldara and Iacoviello (2022b))



3.3 Terrorism, economy, and financial markets

As we have now covered what is meant by terrorism and terror attacks, the conversation can be continued about how the terror attacks affect the economy and markets. Already Keynes (1920) investigated the relationships between war, peace, and economy in the wave of World War I. According to Bloomberg et al. (2004), such conflicts as wars have drawn more interest among their time economists whereas terrorism and terror attacks have been much more narrow research area. However, dreadful events for instance in the United States, Middle East, and Europe, has raised economic-based questions related to terrorism and especially, to the threat of terrorism against markets and economy.

Previous academic research indicates that the economic effects, effects on financial markets and effects on exchange rate relationship to terror attacks have been investigated by many researchers (see e.g., Hassapis et al., 2018; Maitah et al., 2017; Balcilar et al., 2017). However, the research area is still very narrow. Where currency markets, exchange rates and their relationship to terror attacks have not been that large research area, have economic effects as well as stock and

bond markets among financial markets been investigated which have raised interest in academic literature.

Based on previous academic literature, the economic effects of terrorism can be seen as an interesting research area. Terror attacks often start as quickly as they end but the effects can be long lasting. Lenain et al. (2002) were one of the first ones who did pioneering research related to terrorism and its effects on the economy. According to Lenain et al. (2002) terror attacks immediately cause a direct impact which can be kept as short-term, but in addition, terror attacks have some other consequences, which can be long-term. Lenain et al. (2002) discussed three different channels in their research on how terror attacks can affect OECD countries. The first of these channels can be through the insurance industry: Lenain et al. (2002) found that insurance premiums have hiked in case of a terror attack. This can be for example explained by increased insecurity (Lenain et al., 2002). Furthermore, Lenain et al. (2002) highlighted that terror attacks can cause economic influence through higher trade costs and naturally governments increasing the security spending and military related actions.

Krugman (2004) divided the costs caused by terrorism into direct and indirect costs. Direct costs can be seen immediately after the terror attack and often can become very expensive through new needed infrastructure (Krugman, 2004). Krugman (2004) also pointed out that these direct costs can be seen in the case of rare disasters and drastic events such as natural catastrophes. In addition, Krugman (2004) listed indirect costs as security and defense spending, decrease in travelling and behavioral responses such as fear of terror similarly than Lenain et al., (2002). Moreover, Johnston and Nedelescu (2006) also stated similarly in the IMF working paper that costs can be divided into direct and indirect costs. They highlight that the importance of the indirect costs should be considered as drastic terror attacks do not fade away in investors' minds (Johnston and Nedelescu, 2005). Moreover, Johnston and Nedelescu (2006) expanded the idea of Lenain et al. (2002) that the economic impacts can in addition include medium-term impacts.

Bloomberg et al. (2004) investigated the macroeconomic effects of terror attacks in their research paper. They used a large, unique data set where they combined 177 countries between the years 1968-2000 including emerging and developed economies (Bloomberg et al., 2004). The research showed first evidence related to advanced economies that they tend to be more resilient in case of a terror attack whereas countries with lower developing status faced a stronger, statistically significant relationship to terror attacks (Bloomberg et al., 2004). In addition, Bloomberg et al. (2004) found that terror attacks affect GDP growth as well as that government spending will increase. On one hand these results also supported the evidence by Krugman (2004) and Lenain et al. (2002).

Financial markets can be kept as a fundamental part of the economy. After the attack on the World Trade Centre in New York 2001, a clear increase in research related to financial markets and terrorism can be seen. Johnston and Nedelescu (2006) highlighted that especially after the attack of 9/11, the direct costs encumbered the financial markets but moreover, market volatility peeked

as well as the investor's uncertainty and confidence towards markets. All in all, Johnston and Nedelescu (2006) indicated that the costs of the terror attacks burdens almost all the markets across the economy. Furthermore, Chen and Siems (2004) investigated terrorist and military attacks including for example the September 11th and they highlighted in their results that the effect shortly after the attack can be large on capital markets. Moreover, integration as well as possible contagion effects in the markets drove shocks to move fast between areas (Chen and Siems, 2004). Thus, it can be expected that between Unites States and Europe spillover effect are seen.

Similarly, Nikkinen et al. (2006) stated that the widespread effect on integrated financial markets makes terror attacks as well as other unexpected shocks affect markets. More specifically, Nikkinen et al. (2006) investigated the effects of September 11th on stock markets and stock market volatility with a data set of over 50 equity markets including the area of MENA (Middle East and North Africa). Results showed that the effect of September 11th on stock markets varies between regions and moreover, the integrated economies are affected more which on the other hand indicates also that international diversification could be useful for the investors (Nikkinen et al., 2006). Also, more recent research from the MENA area by Mnasri and Nechi (2016) indicated that among emerging countries the effect is more powerful and long lasting. In other words, the effect of terrorism in financial markets is not straightforward.

More recent research has been conducted by Papakyriakou et al. (2019) who investigated the G7 countries terror attacks during the years 1998-2017: they also included the investor sentiment in their research. The results of the research showed that the stock markets are negatively affected by the attack on the event day as well as the next day (Papakyriakou et al., 2019). Papakyriakou et al. (2019) results, in addition, indicated that the effect can last even ten days on the stock markets after the terror attack. These results differ from previous empirical evidence which claims that the effect of terror attack is only short-term.

3.4 Terrorism and currency markets

Where the effect of terror attacks on financial markets, especially to stock markets, stock market performance and stock market volatility have been investigated, the exchange rates and currency markets have drawn rather small interest among researchers. Additionally, the academic literature based on terror attacks and exchange rates is rather new. Among the first researchers who investigated terror attacks and exchange rates are Eldor and Melnick (2004). They investigated terror attacks that took place in Palestine during the years 1990-2003 but, however, found that there is no specific effect on exchange rates as well as they found similar results in addition in the stock markets (Eldor and Melnick, 2004). However, later research has shown that the relationship between terror attacks and

exchange rates exists, but the effect can be positive or negative depending on the country or region.

According to Hassapis et al. (2018) terrorism created uncertainty in the economy and this way is associated with the exchange rates. They divide the previous literature into two parts: economic impacts and market impacts (Hassapis et al., 2018). Hassapis et al. (2018) made interesting findings related to exchange rates: some of the currencies depreciate whereas some currencies can appreciate. This can indicate that there are some safe-haven currencies, such as Swiss franc. Similar findings are also possible in this thesis.

Maitah et al. (2017) investigated the effect of terror attacks on Turkish lira versus pound sterling exchange rate and found that in case of attack, the exchange rate depreciates. In addition, Maitah et al. (2017) found short- as well as long-term effects on exchange rates. Similarly, Balcilar et al. (2017) investigated the dollar-pound exchange rate and its movements relative to terror attacks. They used causality-in-quantiles method and showed that in almost all quantiles the terror attack has an effect to exchange rate (Balcilar et al., 2017). Very recent research has been conducted by Markoulis (2021) who investigated the terror attacks and euro. The research showed that the exchange rate depreciates but the effect is rather small (Markoulis, 2021). In addition, Markoulis (2021) results showed that some of the currencies can act as "safe havens" in case of a terror attack. Hassapis et al. (2018) found similar results for example in the case of Swiss franc.

3.5 Concept of rare disasters

Rare disaster literature forms a wide and growing area: for example, Zhou et al. (2021) have done recent research where they treated Covid-19 as a rare disaster and investigated the effects on exchange rates. Earlier research has been conducted for instance by Farhi and Gabaix (2016) and Berkman et al. (2011). Taking into consideration that geopolitical risk index indicated that 9/11 caused a peak in the index according to Caldara and Iacoviello (2022a), it raises a question can also the terror attacks act as rare disasters similarly than Covid-19, political or financial crises or natural catastrophes. In addition, Abadie and Gardeazabal (2008) represented terrorism as catastrophic risk for the economy. In general, Berkman et al. (2011) see research related to rare disasters important because probability of these disasters may explain for example premium or volatility puzzles. In addition, according to Park and Park (2020), rare disasters largely affect asset prices and thus can be seen as a lowering effect on consumption and productivity.

Recently, Zhou et al. (2021) published research where they investigated the relationships between exchange rates, Covid-19 as rare disaster and macroeconomic policies. Their sample was taken from 27 different countries including both developed and emerging countries (Zhou et al., 2021). Zhou et al. (2021)

conducted two different regression analyses. The first regression was meant to confirm that there is a connection between Covid-19 and currency risk premium (Zhou et al., 2021). Previous empirical evidence has shown that the currency risk premium (deviation from uncovered interest rate parity) can largely be affected by crisis and rare disasters (Farhi and Gabaix, 2016). A similar model is also used in this master's thesis to investigate whether geopolitical risk indices reflect the rare disaster risk. When Zhou et al. (2021) confirmed the association in their research, they investigated with simple regression models how the risk of disaster affected the exchange rate. Moreover, Zhou et al. (2021) found that in emerging countries currency seems to be depreciating while in developed countries the effect was small, less than 0,01 %.

Another recent study about the rare disasters is conducted by Park and Park (2020). They investigated the tension between the two Korea's relative to exchange rates and found that the South Korean exchange rate depreciates in case of negative information. Furthermore, rare disasters have also been researched by Farhi and Gabaix (2016). They investigated and formed a new model for the exchange rate determination where the possibility of a rare disaster can be seen as one of the determinants of risk premia (Farhi and Gabaix, 2016). Later this model has been applied for example by Zhou et al. (2021) in their research. According to Farhi and Gabaix (2016) the rare disaster is time-varying which, on the other hand, affects exchange rates and their volatility. Moreover, Berkman et al. (2011) researched international political crises and their effect on the stock markets. The results by Berkman et al. (2011) indicated that the relationship between these two objectives exists as well as that the findings are in line with the time-varying disaster probability models.

As can be concluded based on the preview of the previous literature the connection between terror attacks and economic factors including exchange rates can be found. However, the results vary and especially the results are mixed between developed and emerging countries. The question that stands is what are the attributes of terror attacks that cause abnormal returns for exchange rates and how much. In addition, only the empirical estimation results can show could the rare disaster term be used when talking about geopolitical risk in terms of terrorism.

4 DATA AND METHODOLOGY

The data and methodology chapter builds the empirical base for this thesis as well as models the used methods. The chapter starts with introducing the research hypotheses formed for this thesis. Second, this chapter presents the selection criteria for investigated terror attacks and aims to describe the terror attacks' characteristics in selected emerging and developed countries. Then the descriptive statistics for all significant variables used in the empirical models are presented. Last part of this chapter explains the models and empirical methods used to answer the determined research questions: in total, the models are divided into three parts.

4.1 Research hypotheses

This thesis aims to provide empirical support linking the terror attacks, and selected exchange rates and seek for differences between developed and emerging countries. The purpose is to choose terror attacks from selected developed and emerging countries to see what kind of effect they cause in exchange rates and moreover, which and how selected attributes affect to abnormal returns. The corresponding hypotheses related to research questions are listed below.

First hypotheses pair stands for selected developed countries:

> H0: The relationship between terror attacks and exchange rates in developed countries remains small.
>
> H1: The relationship between terror attacks and exchange rates in developed countries is long-lasting and statistically significant in most cases.

Second, the hypotheses pair for selected emerging countries is represented:

> H0: The relationship between terror attacks and exchange rates in emerging countries is small but exists.
>
> H1: The relationship between terror attacks and exchange rates in emerging countries is not statistically significant.

4.2 Selection of terror attacks

This thesis focuses on terror attacks that have occurred during the years 2000 to 2020. This period captures interesting, but also drastic attacks that have also been studied before in the previous academic literature. In addition, the beginning of the 21st century is a natural start for the period due to the largest terror attack in history in 2001, September 11th. Moreover, this paper aims to capture all the significant terror attacks and create a platform which allows to investigate the abnormal returns of exchange rates as well as explanatory variables of these returns. This paper uses Global Terrorism Database to obtain data related to the terror attacks.

Global Terrorism Database (2022) is maintained by the National Consortium for the Study of Terrorism and Responses to Terrorism (START): a Department of Homeland Security Centre of Excellence led by the University of Maryland. According to Global Terrorism Database (2022), the database can be kept as most comprehensive while including data related to terror attacks between years 1970 and 2020 with more than 200 000 terror attacks. Global Terrorism Database (2022) offers comprehensive data of the specific attack including for example event date, region, country, city, number of wounded and killed people, property damage, attack type, target type, perpetrator group and weapon type.

Figure 4. Human casualties by terrorism in eight selected emerging and developed countries. (Source: Global Terrorism Database, 2022)

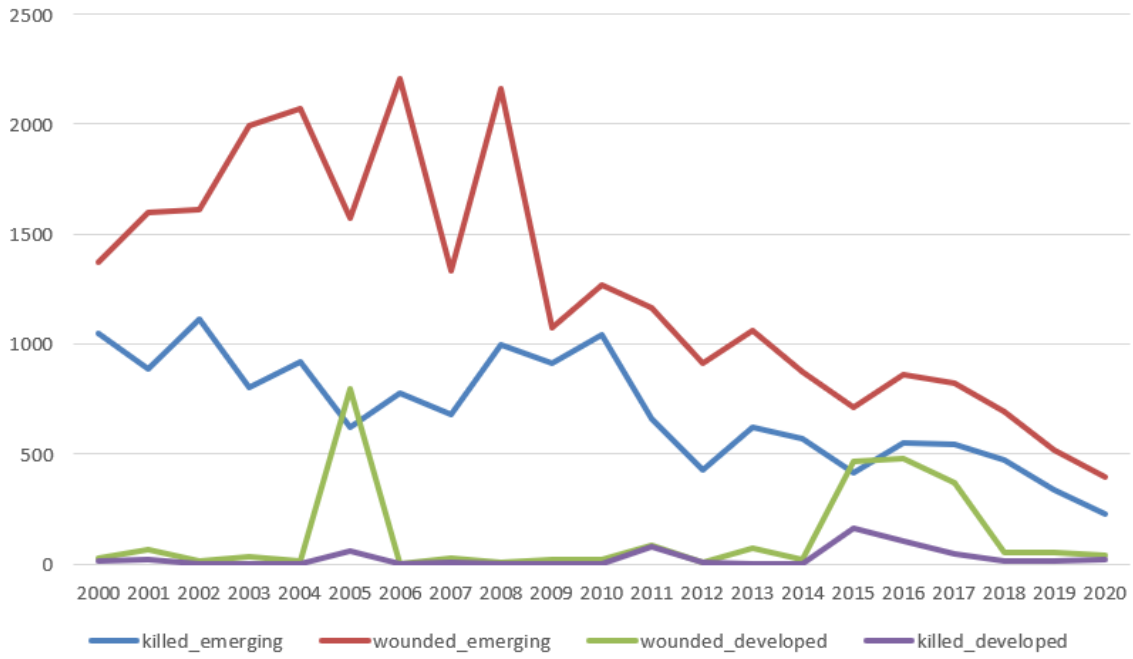


Figure 4 above shows the wounded and killed human casualties by terrorism during the years 2000-2020 in selected emerging and developed countries. Green and violet lines represent the amount of killed and wounded people in selected developed countries respectively. Blue and red lines represent the killed and wounded people in selected emerging countries. As can be clearly seen from figure 4, the amount of fatal as well as non-fatal casualties is relatively less in developed countries than in emerging countries. A few peaks in non-fatal casualties among developed countries can be seen, but otherwise the amount is steady over the years. However, this figure does not include terror attacks from United States even if two attacks are included to the sample, for example 9/11. Naturally 9/11 would have caused a peak for fatal and non-fatal human casualties among developed countries. Peak in 2005 among developed countries is caused by the London Bombings in United Kingdom. On the other hand, the increase in wounded people between the years 2015-2017 in developed countries is caused by the large terror attacks in Paris, Nice and on London bridge. Among the emerging countries the amount of non-fatal casualties' changes, however, more during the selected years. However, trendline of the figure 4 shows that the number of fatal and non-fatal casualties is decreasing in emerging countries during the selected years.

To describe the heterogeneity of the terror attacks in selected emerging and developed countries, figures 5 and 6 represent the different kinds of characteristics of terror attacks: attack types, target types, and weapon types. This information is again gathered from Global Terrorism Database (2022). All the characteristic types include more than four sub-categories but for the essence of this

thesis, only the four largest categories in each set of characteristics are shown. The largest sub-categories in attack type category include bombings, armed assaults, and infrastructure attacks in developed and emerging countries: however, bombings can be clearly seen as the most usual attack type. This can be due to its possibility for massive destroying effect. In emerging countries, hostage taking is the fourth sub-category whereas in developed countries it is unarmed assault.

Figure 5. Characteristics of terror attacks in selected emerging countries during the years 2000-2020. (Source: Global Terrorism Database, 2022)

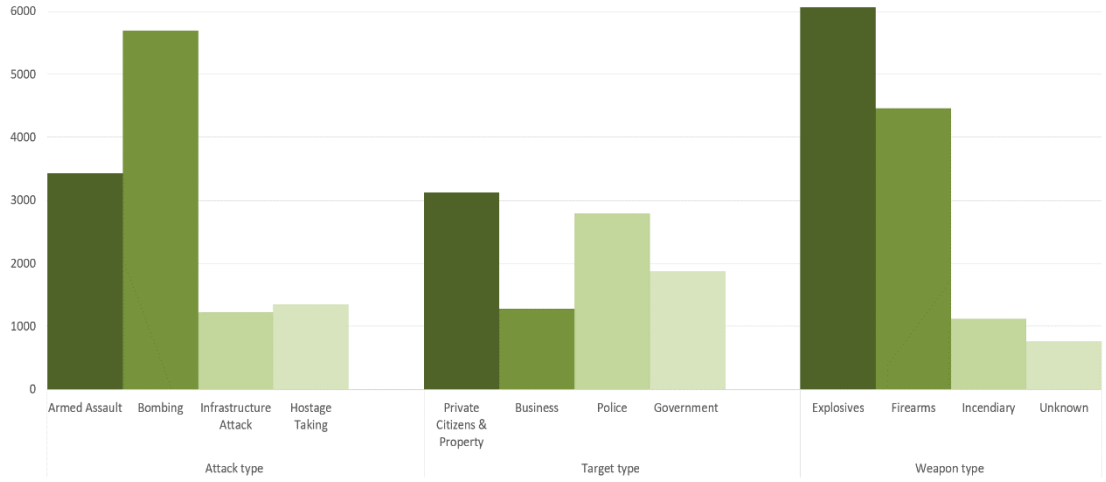
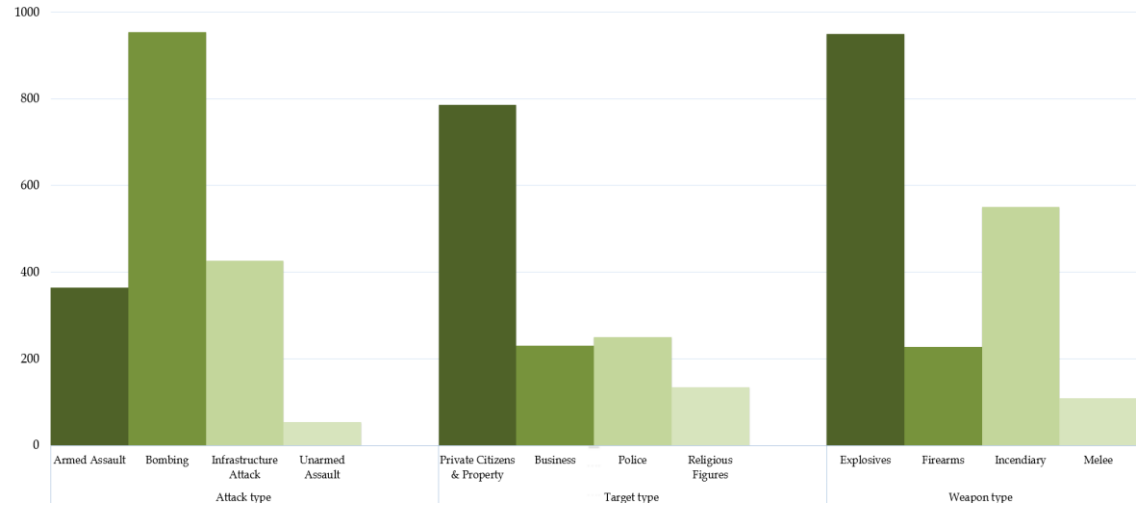


Figure 6. Characteristics of terror attacks in selected developed countries during the years 2000-2020. (Source: Global Terrorism Database, 2022)



Sub-categories in target types are also similar in developed and emerging countries: private citizens and property, business, and police. In emerging countries, government is the fourth sub-category whereas in developed countries in is religious figures. However, the largest target types in developed as well as in emerging countries are the private citizens. One reason for this is that terror attacks

among private citizens and property can cause massive damage as well as draw lots of media attention. Last category, the weapon type includes explosives, firearms, and incendiary in both set of countries. However, again the fourth differs due to in emerging countries it is unknown and in developed countries the fourth largest weapon type is a melee. The largest weapon type in both set of countries are the explosives which on the other hand supports the most used attack type being bombing.

Now covered figures 4, 5 and 6 related to the terror attacks include all terror attacks that took place in selected emerging and developed countries between the years 2000 and 2020. In this paper, we primarily want to see how the terror attacks affect to exchange rate. For this reason, all the terror attacks described in the previous figures are not selected. From all the terror attacks, this paper tries to capture the most significant terror attacks that for example also other studies have seen relevant on other financial market sectors. To meet the aim of this research, the selection of terror attacks plays an essential role. Papakyriakou et al. (2019) selected terror attacks in their research based on to filter the duplicate attacks and exclude ambiguous attacks. Similarly, Hassapis et al. (2018) narrowed down the terror attacks in selected countries creating a platform. While keeping this in mind, the next paragraphs explain more deeply the selection criteria for terror attacks.

Office of United Nations and their General Assembly (no date) keeps terror attack significant when there is death or serious bodily injury and serious damage to properties, places, facilities, or systems resulting in economic loss. The selection of terror attacks for this thesis uses this definition also as the main guideline. Similarly, Hassapis et al. (2018) used similar criteria by US government's Incident Review Panel Criteria in their research to select the significant terror attacks.

In this thesis, the aim is to create an interesting platform of terror attacks while including the most significant terror attacks to the sample. Given the definition by Office of United Nations and their General Assembly (no date), the terror attacks selected in this paper have caused serious bodily harm (fatal and non-fatal casualties) and damaged properties (catastrophic, major, or minor). Moreover, the duplicates and ambiguous attacks are excluded from the sample. For example, the October 2017 attack in the United States, Las Vegas, was left out from the sample, because it was conducted by individual and was not related to any terrorist group by certainty. On the other hand, terror attacks that happened during the same day are combined: for example, several terror attacks in Mumbai, India that took place in November 2008. The selection of the attacks started with the largest ones based on fatal and non-fatal casualties and property damage. Thus, most of the selected terror attacks have more than 50 wounded people. In selected emerging countries, the amount of terror attacks was large, but the amount fatal and non-fatal casualties remained rather small. This is why the sample also includes terror attacks that have a smaller number of human casualties. In these cases, the selection is made based on total numbers of casualties and the largest ones are selected. In order to select the suitable terror attacks, also large

amount of previous literature related to other financial markets, for example stock markets were went through. This ensured that terror attacks that have been seen affecting stock markets, are also investigated in foreign exchange market setting. For instance, Nikkinen et al. (2008) stated that September 11th attacks affected especially the stock market volatility. Furthermore, Papakyriakou et al. (2019) included Paris and Nice attacks for their selection when investigating terror attacks and stock markets.

Based on the Global Terrorism Database (2022), most of the attacks during the years 2000-2020 were caused by bombings as well as those were also the most harmful for humans and property. In addition, due to information clustering, to see possible spill over effects, also significant terror attacks from the United States were included in the selection of terror attacks. For example, Kumar and Liu (2013) found that terror attacks cause spill over effects between countries that are trading partners. This effect can be especially seen among larger economies (Kumar and Liu, 2013). Due to this, two terror attacks selected from the United States complete the terror attack data set used in this thesis. In total, this paper investigates 22 terror attacks from the selected developed and emerging countries. The list of the selected terror attacks can be found from Appendix 1.

In Appendix 1 each terror attack is described in detail including country, region, event date, number of wounded people, number of killed people, attack type, target type, weapon type as well as property damage (Unknown, minor, major, or catastrophic). Appendix 1 shows that most of the attacks are bombings targeting private citizens or transportation. Most often the weapon type is explosives.

Comparing selected developed and emerging countries, terror attacks were significantly more common in emerging countries than in developed countries (Global Terrorism Database, 2022). However, most of the attacks in emerging countries were small which include only a few casualties and minor damage to properties. Exception in this was South Africa where only few larger terror attacks took place during the years 2000-2020. As whole, the selection of terror attacks tries to capture attacks that have drawn a lot of attention or in some other way, have been exceptional. Terror attacks selected from France include for example attacks from Paris (2015) and Nice (2016). From the United Kingdom, there are in total three attacks in the sample: two from London and one from Manchester. In addition, a group of large terror attacks that took place in Mumbai, India in November 2008 has been included to the sample due to according to Gunasekar et al. (2018) the attack can be seen as an attack against Indian's financial center. Finally, as already mentioned for measuring the spillover effects of terror attacks, two drastic terror attacks from United States are included: the catastrophic 11th of September and Boston marathon bombings.

4.3 Descriptive statistics

To investigate the exchange rates, this paper investigates selected developed and emerging countries' currencies against the US dollar. The chosen exchange rates are spot rates (bilateral rates against US dollar). The descriptive statistics section includes both spot as well as forward values for selected exchange rates because those values are used to calculate the abnormal returns.

The exchange rate data as well as other financial data related to estimation models is obtained from Refinitiv Eikon Database as well as Federal Reserve Economic Database (FRED). All the data consists of daily data including all the trading days. However, the only exception is the short-term interest rates that are monthly rates: thus, the interest rates are expanded to daily level. In addition, Caldara, and Iacoviello (2022b) database is used for daily observations for all three geopolitical risk indices. Table 1 lists the selected countries, corresponding currencies, and their abbreviations.

The sample includes eight countries and corresponding currencies, which creates an interesting platform to investigate the effect of terror attacks. Selected developed countries are widely used also in previous studies. Recent empirical evidence by Hassapis et al. (2018) and Markoulis (2021) found that for instance, Swiss franc appreciated during terror attacks. Moreover, Norway and France also create an interesting addition for the currencies due to terror attacks that have occurred in those countries during the period 2000-2020. Some of those terror attacks have also drawn large media attention, for example 2011, in Norway Utoya island and in 2015, in France Paris.

Table 1. List of the selected emerging and developed countries.

Country	*Currency*	*Currency abbreviation*
France	Euro	EUR
Norway	Norwegian krone	NOK
Switzerland	Swiss franc	CHF
United Kingdom	Pound sterling	GBP
Brazil	Brazilian real	BRL
Russia	Russian ruble	RUB
India	Indian rupee	INR
South Africa	South African rand	ZAR

As emerging countries this paper investigates the BRICS countries. Previous literature has also investigated the emerging countries, but as far as the author's knowledge the BRICS countries have not been studied related to terrorism and terror attacks. Because the aim of this thesis is to primarily investigate immediate effects of terror attacks to exchange rates, China is not included in the sample due to pegged and not floating exchange rate.

Table 2. Descriptive statistics for spot and forward exchange rate logarithmic returns.

Variable	*Mean*	*Median*	*Min*	*Max*	*Standard deviation*	*Skewness*	*Kurtosis*	*ADF*	N
EURUSD_spot	-0.00001	0	-0.046	0.038	0.006	-0.139	5.938	-17.110***	5479
EURUSD_forward	-0.00004	0	-0.046	0.038	0.006	-0.136	5.756	-15.787***	5479
CHFUSD_spot	-0.0001	0.00004	-0.114	0.085	0.007	-0.853	29.282	-21.696***	5479
CHFUSD_forward	0.0001	0.00005	-0.114	0.085	0.007	-0.856	29.415	-14.085***	5479
NOKUSD_spot	0.00001	0	-0.065	0.061	0.008	0.1478	8.433	-18.001***	5479
NOKUSD_forward	0.00001	0	-0.064	0.061	0.008	0.147	8.470	-18.327***	5479
GBPUSD_spot	0.00003	-0.00003	-0.045	0.083	0.006	0.493	13.448	-17,902***	5479
GBPUSD_forward	0.00003	-0.00002	-0.044	0.083	0.006	0.482	13.277	-16,371***	5479
BRLUSD_spot	0.00019	0	-0.118	0.097	0.010	0.120	13.420	-16.421***	5479
BRLUSD_forward	0.00019	0	-0.095	0.183	0.011	0.911	23.912	-20.930***	5479
RUBUSD_spot	0.00018	0	-0.155	0.143	0.008	0.548	63.971	-8.793***	5479
RUBUSD_forward	0.00017	0	-0.147	0.151	0.008	0.938	61.680	-20.187***	5479
INRUSD_spot	0.0001	0	-0.031	0.033	0.004	0.295	10.246	-9.373***	5479
INRUSD_forward	0.0001	0	-0.031	0.032	0.004	0.289	10.431	-19.531***	5479
ZARUSD_spot	0.0001	0	-0.085	0.098	0.010	0.287	7.694	-16.461***	5479
ZARUSD_forward	0.0001	-7.64e-06	-0.085	0.099	0.010	0.295	7.711	-18.685***	5479

Notes: The significance levels are as following: 1%=***, 5%=** and 10%=*. The abbreviations for currencies can be seen from table 1. Both spot and forward values are represented in the table as logarithmic returns. Min stands for the minimum value and Max for the maximum value of the variable. ADF stands for Augment Dickey Fuller test (H_0= unit root) and N number of observations.

Above, in table 2 the descriptive statistics for selected exchange rate spot and forward values are given. The descriptive statistics table represents mean, median, minimum, and maximum values, standard deviation, skewness, kurtosis, and number of observations (N). Exchange rate spot and forward values normally act as stationary variables, but this has been ensured with Augmented Dickey-Fuller test (ADF) as well as with Phillips-Perron test (PP). The results from ADF test are included in the descriptive statistics table: however, both tests clearly rejected the null hypothesis and stated that all data series are stationary i.e., do not contain a unit root.

The descriptive statistics for the spot and forward exchange rates are calculated based on logarithmic returns for the trading days between 2000-2020. The formula to calculate the returns is represented in part 4.4.2. In table 2, the mean and median are close to zero in all cases. This indicates that the spot and forward data of exchange rates is symmetric. Minimum (min) and maximum (max) values as well as the standard deviation describe how spread out the data is. The extreme values are generally larger in the case of emerging countries than in developed countries. In addition, the standard deviation indicates that emerging countries' currency pairs are more spread out. Skewness as well as kurtosis show the

asymmetry of the data set. Kurtosis is positive in all selected exchange rates whereas skewness shows some negative signs in cases of Euro and Swiss franc for spot and forward values. The data is collected from a 20-year period which makes the number of observations to be 5479. The sample includes only the trading days.

Table 3. Descriptive statistics for additional variables of empirical models.

Variable	*Mean*	*Median*	*Min*	*Max*	*Standard deviation*	*Skewness*	*Kurtosis*	*ADF*	N
GPR index	112.025	99.277	9.491	1045.604	68.331	4.837	42.856	-4.046***	5479
GPR threat index	108.818	96.649	7.892	703.488	59.828	2.432	15.136	-7.717***	5479
GPR attack index	116.648	95.203	0	1627.428	112.045	6.0935	58.531	-4.131***	5479
FFD	-0.001	0	-2.564	0.693	0.048	-30.127	1514.178	-22.440***	5479
Euro_short	-0.0004	0	-1.755	0.491	0.035	-24.405	1190.410	-39.164***	5479
Switzerland_short	-0,0009	0	-3.555	2.606	0.083	-13.939	997.493	-75.188***	5479
Norway_short	-0.0004	0	-0.929	0.308	0.020	23.854	1000.935	-8.687***	5479
United Kingdom_short	-0.001	0	-0.677	0.305	0.022	-15.752	404.628	-13.540***	5479
Brazil_short	-0.0004	0	-0.178	0.154	0.009	-6.044	137.599	-16.088***	5479
India_short	-0.0001	0	-0.635	0.635	0.013	1.597	1652.875	-50.216***	5479
Russia_short	-0.0003	0	-0.473	0.573	0.031	0.468	105.009	-22.260***	5479
South Africa_short	-0.0002	0	-0.203	0 .119	0.007	-8.976	237.626	-12.890***	5479

Notes: FFD stands for Federal Funds rate of United States. All the short-term rates are logarithmic returns of 3-month interbank rates expanded from monthly to daily level. The significance levels are as following: 1%=***, 5%=** and 10%=**. Min stands for the minimum value and Max for the maximum value of the variable. ADF stands for Augment Dickey Fuller test (H_0= unit root) and N number of observations.

Results from table 3 on the previous page show the descriptive statistics for GPR indices, federal funds rate of US (FFD) and eight short-term interest rates from selected developed and emerging countries. These additional variables are used to model the UIP estimations as well as in explanatory regression models. All the GPR indices values are calculated only for the trading days, even if the daily values are given on each day of the year for all three indices. Thus, the number of observations is 5479 for all other variables. In the case of GPR indices the mean and median are similar. The mean values are used to model the GPR index dummy variables for explanatory regression models. However, the spread out that the minimum and maximum values as well as the standard deviation indicate is large. For example, the maximum value for GPR attack index is 1627,428 whereas the minimum value for the index is zero. Kurtosis for GPR index as well as GPR attack index are also large compared to kurtosis of GPR threat index. When the kurtosis is large, it indicates that the data is in the tails of distribution. For short-term interest rates as well as for FFD the mean and median values are

both close to zero if not zero. However, there are some differences between minimum and maximum values between the variables. For FFD, Euro area and Switzerland the minimum values are notably larger than in case of other similar variables. Also, for Switzerland the maximum value is large compared to others. Kurtosis values also show interesting results. In most cases the values are massive which clearly indicates that the data is located strongly in the tails.

Table 4 on next page describes the correlations of coefficients that are used to describe and explain the selected terror attacks. These variables include number of wounded people, number of killed people, weapon types (explosives, firearms, melee, and vehicle), region (Eastern Europe, North America, South America, South Asia, Sub Saharan, and Western Europe), attack types (bombing, hijacking, and hostage) and target types (business, government, private citizens, transportation, and religious figures). Correlation can vary between -1 and +1: the stronger the correlation between two variables is when it is closer to -1 or +1. In this thesis the strong correlations between selected variables are bolded in table 4. For example, very strong positive correlation can be seen between variables killed and wounded as well as vehicle and wounded. Also, positive correlation between firearms and armed assault can be found.

In addition to correlation coefficient matrix, variance inflation factor (VIF) – test is conducted for variables that were correlating strongly in table 4. However, results from that are not presented in this thesis. VIF indicated the same between selected variables as the table 4. Due to some strong correlations between variables, these variables are separated into different linear regression models to avoid problems on multicollinearity. A case in point, variables Wounded and Killed are separated to different explanatory models in the empirical part.

Table 4. Correlation coefficient matrix of used explanatory terror attack variables in linear regressions. Strong correlations between two variables are highlighted with bolding.

	Wounded	Killed	Explosives	Firearms	Melee	Vehicle	Eastern Europe	North America	South America	South Asia	Sub Saharan	Western Europe	Armed assault	Bombing	Hijacking	Hostage	Business	Government	Private Citizens	Religious figures	Transportation
Wounded	1.0000																				
Killed	**0,996**	1.0000																			
Explosives	-0.2274	-0.2076	1.0000																		
Firearms	-0.1458	-0.1510	-0.7593	1.0000																	
Melee	-0.0753	-0.0953	-0.3568	-0.1935	1.0000																
Vehicle	**0.9967**	0,9876	-0.2467	-0.1338	-0.0629	1.0000															
EasternEurope	-0.0990	-0.1009	0,378	-0.2870	-0.1348	-0.0933	1.0000														
NorthAmerica	0,6904	0,6644	-0.0510	-0.1935	-0.0909	0,6916	-0.1348	1.0000													
SouthAmerica	-0.0535	-0.0693	-0,051	-0.1338	-0.0629	-0.0435	-0.0933	-0.0629	1.0000												
SouthAsia	-0.0626	-0.0243	0,3194	-0.0410	-0.1348	-0.0933	-0.2000	-0.1348	-0.0933	1.0000											
SubSaharan	-0.1166	-0.1430	-0.5292	0,451	0,2697	-0.0933	-0.2000	-0.1348	-0.0933	-0.2000	1.0000										
WesternEurope	-0.1580	-0.1442	-0.0436	0,49306	0,5403	-0.1615	-0.3464	-0.2335	-0.1615	-0.3464	-0.3464	1.0000									
Armed assault	-0.1798	-0.1962	**-0.9165**	**0,8284**	0,3892	-0.1615	-0.3464	-0.2335	-0.1615	-0.1155	0,5774	0,77153	1.0000								
Bombing	-0.1895	-0.1789	0,8452	-0.6417	-0.3015	-0.2085	0,4472	-0.0000	0	0,378	-0.4472	-0.2582	-0.7746	1.0000							
Hijacking	0,9967	0,9876	-0.2467	-0.1338	-0.0629	1.0000	-0.0933	0,6916	-0.0435	-0.0933	-0.0933	-0.1615	-0.1615	-0.2085	1.0000						
Hostage	-0.0628	-0.0468	-0,0468	-0.1935	-0.0909	-0.0629	-0.1348	-0.0909	-0.0629	-0.1348	-0.1348	-0,2335	-0.2335	-0.3015	-0.0629	1.0000					
Business	-0.0628	-0.0468	-0,0468	-0.1935	-0.0909	-0.0629	-0.1348	-0.0909	-0.0629	-0.1348	-0.1348	-0,2335	-0.2335	-0.3015	-0.0629	1.0000	1.0000				
Government	-0.0935	-0.1013	0,44375	0,24028	-0.1140	-0.0788	-0.1690	-0.1140	-0.0788	0,2381	-0.1690	0,2277	-0.0325	0,875	-0.0788	-0.1140	-0.1140	1.0000			
Private Citizens	0,3211	0,3076	-0.5733	0,5966	-0.1935	0,3249	-0.2870	0,4699	-0.1338	-0.2870	0,451	-0.1183	0,4497	-0.4583	0,3249	-0.1935	-0.1935	-0.2425	1.0000		
Religiousfigures	-0.1053	-0.1103	-0.3024	-0.0410	0,6742	-0.0933	-0.2000	-0.1348	-0.0933	0,169	0,6944	-0.1155	0,3464	-0.2236	-0.0933	-0.1348	-0.1348	-0.1690	-0.2870	1.0000	
Transportatation	-0.1239	-0.1110	0,5976	-0.4537	-0.2132	-0.1474	0,6325	-0.2132	0,1066	-0.0791	-0.3162	-0.1826	-0.5477	0,7071	-0.1474	-0.2132	-0.2132	-0.2673	-0.4537	-0.3162	1.0000

4.4 Specification of the models

In the next sub-chapters, the different empirical models are represented to answer the research questions of this thesis. All the models are investigated with the empirical software StataSE 17. In addition, Microsoft Excel is used to modify the selected data as well as form graphs and additional descriptive statistics. Results and analysis related to the represented models are shown in chapter 5 of this thesis.

4.4.1 Linear regression model for UIP deviation and GPR indices

The theoretical framework of this paper is built on two parts where the first is the determination of short-term exchange rate with uncovered interest rate parity. To investigate whether geopolitical risk in terms of terrorism reflects rare disaster risk which the UIP deviation (currency risk premium) can be affected by and to answer for the first sub-question of this thesis, simple regression model similar than by Zhou et al. (2021) is conducted. The model is tested separately for selected developed and emerging countries and for all GPR indices.

Fixed effect regression with panel data could allow time and country fixed effects. However, in case of fixed effects the empirical estimations showed that due to collinearity variables were omitted. Thus, a simple regression model without the fixed effects is conducted. The model is derived as following:

$$ExRet_{it} = a + \beta_1 GPR\ index_{it} + \varepsilon_{i,t} \quad (2)$$

where:

i = country
t = time
$ExRet_{it}$ = excess return/UIP deviation (corresponding to formula 1)
GPR index = geopolitical risk index
$\varepsilon_{i,t}$ = the error term

The geopolitical risk index consists of three measures represented in the previous literature chapter: general GPR index, GPR index with threats and GPR index with occurred geopolitical events. Due to this, in total 6 different regression models are estimated, separately for developed as well as emerging countries. The results for these models are represented in part 5.1.

4.4.2 Event study methodology

The regression model represented in the previous part investigate do the GPR indices reflect rare disaster risk. However, the next empirical model investigates more closely the selected terror attacks from eight different emerging and developed countries. With the event study methodology, this thesis tries to establish abnormal as well as cumulative abnormal returns that are caused by terror attacks and thus affect the exchange rates. Event study is conducted on daily level data in order to see specifically the possible results on attack day as well as next trading days after the terror attack.

Event study methodology is used in number of research which investigate the terror attacks and financial markets (see e.g., Chen and Siems, 2004; Hassapis et al., 2018; Markoulis, 2021). Originally, event study methodology was established by Fama, Fisher, Jensen and Roll already in 1969 (Fama et al., 1969). Research investigated stock splits and was based on the idea that markets react to information immediately after the announcement (Fama et al. 1969). Thus, the theory behind event study is the efficient market hypothesis or EMH (Ullah et al., 2021). According to Ullah et al. (2021) event study can be used in a range of studies while it origins from financial field. Event study methodology in addition holds many pros, for example capturing events and examining its effects on specific variables (Ullah et al., 2021). This is why also this thesis uses event study methodology to investigate the relationship between terror attacks and exchange rates. Furthermore, most of the recent studies related to terror attack events have been using event study methodology as their main empirical research method. Selected terror attacks from Appendix 1 are used as events in this context. As event study is conducted the objective is to see are the abnormal returns of exchange rates statistically different from zero as well as will the cumulative abnormal returns be statistically significant. Previous research has found statistically significant results in both cases (see e.g., Chen and Siems, 2004; Hassapis et al., 2018; Markoulis, 2021).

The first step in the event study method is to change exchange rates into returns. In this paper, similar method for logarithmic returns is used as Hassapis et al. (2018) and Markoulis (2021) used in their studies. The spot and forward values of exchange rates against US dollar are changed to natural logarithmic returns with the following equation:

$$R_{it} = \ln\left(\frac{P_{it}}{P_{it-1}}\right) \tag{3}$$

Where:

i = country
t = time
R_{it}= logarithmic return
P_{it} = value of exchange rate in country i at time t

As a general rule, the abnormal returns (AR_{it}) are calculated as subtractions between returns (R_{it}) and expected returns ($E(R_{it})$) from specific time range as formula 4) indicates (see e.g., Chen and Siems, 2004; Hassapis et al., 2018; Markoulis, 2021). Abnormal returns refer to returns which can be seen deviating from normal returns in case of an event: abnormal returns show the immediate result of attack in selected exchange rate (Hassapis et al. 2018).

$$AR_{it} = R_{it} - E(R_{it}) \tag{4}$$

However, the equation 4) above does not consider any changes in interest rates. Thus, it only describes the deviation between current event day exchange rate return and average expected exchange rate return from specified period. However, the forward rate unbiasedness hypothesis expresses relationship where forward rates predict the future spot rates in cases where market participants are indifferent to risk and have rational expectations (Delcoure et al., 2003). To consider this, the abnormal returns are calculated with currency forward and spot values as following:

$$AR_{it} = F_t - R_{t+1} \tag{5}$$

Where:

F_t = forward for selected exchange rate
R_{t+1} = spot for selected exchange rate at time t+1

The formula of abnormal return calculates the immediate effect of event, but the cumulative abnormal return (CAR) captures the effect to following days of an event (Hassapis et al., 2018). In other words, CAR refers to additive cumulation of all the abnormal returns occurred after the event day. Similarly, than Hassapis et al. (2018) have tested the CAR, also in this thesis it has been tested is the CAR different from zero. CAR is calculated as following:

$$CAR_{t1,t2} = \sum_{t=t_1}^{t_2} (AR_{it}) \tag{6}$$

CAR is calculated for the event day t, t+1, t+2, and t+3 but only the results for event day and t+1 are presented. As the null hypothesis for the CAR will be tested the null and alternative hypotheses are formed as following similarly than Hassapis et al. (2018):

$$H_0 = CAR_{t1,t2} = 0$$
$$H_1 = CAR_{t1,t2} \neq 0$$

To test whether the abnormal and cumulative abnormal returns are statistically significant, simple t-tests are conducted. Each exchange rate and their abnormal returns are investigated against each 22 terror attacks. Two of these 22 attacks have also taken place in the United States: due to this, possible spillover effects can be investigated. Exchange rates are investigated separately: however, only the relevant attacks against the specific exchange rates are investigated further and represented in the results section.

4.4.3 Regression models for explanatory variables

To investigate closer the abnormal returns as well as cumulative abnormal returns of selected exchange rates, several regression models per exchange rate are conducted. As dependent variable, abnormal returns, and two-day CAR from event study method for selected currency pairs are used. For independent variables, selection of different characteristics of terror attacks as well as GPR attack index are included. However, as table 4 of the correlation coefficient matrix suggests, the variables which correlated strongly together are not included into same regression model. Below all the conducted regression models are represented in order. The results for the regression models are represented in the next chapter. The selected independent (explanatory) variables are better represented in Appendix 2. The explanatory variables are taken from Global Terrorism Database (2022) excluding the GPR attack index which is taken from Caldara and Iacoviello (2022b) database.

The modeling of explanatory variables starts with finding a relationship between abnormal returns and GPR indices. First averages of each GPR index between years 2000-2020 are calculated and then dummy variables are created to differ GPR indexes values which are greater than the averages. After that a simple regression model can be conducted to reveal possible effect of GPR indices increase to abnormal returns of exchange rates. The following model is used:

$$AR_{i,t} = \beta_0 + \beta_1 GPR\ index\ dummy + \varepsilon_{i,t} \quad (7)$$

$AR_{i,t}$*:* stand for the abnormal return that took place on the attack day. Calculated with formula 5).

GPR index dummy: stands for three different forms of GPR index separately (general, threat and occurred attack). From these indices larger values than the averages are separated with dummy variables and tested.

The formula 7) is conducted separately for all currency pairs with three different forms of GPR index (general, threat, and attack). As ordinary linear regression (OLS) can be seen as an effective regression model, it still has some limitations.

According to Gujarati (2011, p. 24) in case of linear regression model the parameters are more precise in case the sample size is larger. For this thesis, 22 terror attacks were selected from eight different countries to investigate the abnormal as well as cumulative abnormal returns. Thus, the linear regression models are conducted for 22 observations, which is a relatively small sample size.

Estrada et al. (2015) introduced a model to investigate the effect of terror attacks on the economy. The model highlighted three different segments of terror attacks: root cause, attack itself and the effect of attacks (Estrada et al., 2015). According to Estrada et al. (2015), it is important to understand that terror attacks are complex events which can stem from various sources and on the other hand, cause various effects. With this paper the same logic is followed with the simple regression models when investigating how the explanatory variables affect cumulative abnormal returns of exchange rates.

Regression models 8) and 9) are conducted to investigate more deeply the characteristics of terror attacks. Moreover, the aim is to see does the characteristics negatively affect two-day cumulative abnormal returns. Cumulative abnormal returns as dependent variable create an interesting but also important point: terror attacks can take place after the trading hours. To some extent the models also follow example by Markoulis (2021), who highlighted that such characteristics of terror attacks affect significantly cumulative abnormal returns of exchange rates. The models are as following:

$$CAR2_{i,t} = \beta_0 + \beta_1 Region + \beta_2 Wounded + \beta_3 Target + \beta_4 Weapon + \beta_5 Attack + \beta_6 GPRIndex + \varepsilon_{i,t} \quad (8)$$

$$CAR2_{i,t} = \beta_0 + \beta_1 Region + \beta_2 Killed + \beta_3 Target + \beta_4 Weapon + \beta_5 Attack + \beta_6 GPRIndex + \varepsilon_{i,t} \quad (9)$$

$CAR2_{i,t}$*:* stands for cumulation of abnormal returns for attack day and the next day.

Region: dummy variable that stands for deviation between developed and emerging countries that are included in the model. France, United Kingdom, Norway, and Switzerland form the developed region. Brazil, Russia, India, and South Africa form the emerging region. If the region is developed, it is marked with 1, otherwise 0.

Wounded: stands for amount of wounded people in case of a specific terror attack.

Killed: stands for amount of killed people in case of a specific terror attack.

Target: describes the target type of specific terror attack. As figures 5 and 6 suggest, the largest target group in selected countries was private citizens. Due to this, it is expected that if the target of a terror attack was private citizens it could have negative effect to CAR2. Thus, variable Target represents a dummy variable where in case of the target is private citizens, it is marked with 1, otherwise 0. A list of specific target types can be found in Appendix 2.

Weapon: describes the weapon type of the specific terror attack. As figures 5 and 6 suggest, the most widely used weapon is explosives. Explosives can also cause massive damage, and due to this, if the weapon was explosives it is marked with 1, other 0. Thus, variable Weapon represents a dummy variable. Explosives can also affect CAR2 negatively. A list of specific target types can be found in Appendix 2.

Attack: describes the attack type of the specific terror attack. As figures 5 and 6 suggest, the most usual attack type is bombing. Due to this if the attack type was bombing, it is marked with 1, otherwise 0. Thus, variable Attack represents dummy variable. Bombings can also cause massive damage to large areas and thus, negatively affect CAR2. A list of specific target types can be found in Appendix 2.

GPRIndex: variable refers to GPR attack index which is included to models for selected developed countries due to estimation results related to formula 7).

5 RESULTS AND ANALYSIS

This chapter of the thesis introduces empirical results with corresponding tables and figures for all the conducted empirical models. In addition, this chapter aims to analyse the results gathered from the empirical parts as well as compare the results to previous research presented in this thesis. The results section starts with regression models related to UIP deviation, following with event study analysis, and finishes with several regression models for explanatory variables of abnormal and cumulative abnormal returns of exchange rates.

5.1 Results for UIP deviation and geopolitical risk indices

Table 5 below describes the results for the first empirical model and aims to answer the first sub-research question how geopolitical risk indices in terms of terrorism affect the UIP deviation. As table 5 indicates, the GPR index is represented in three different forms: general index, index with threat and index with attack.

Table 5. Results for GPR indices and UIP deviation.

UIP deviation	*Developed*	*Developed*	*Developed*	*Emerging*	*Emerging*	*Emerging*
GPR General	-2.20e-06			4.10e-06**		
	(4.82e-06)			(2.14e-06)		
GPR Attack		-5.83e-07			2.30e-06*	
		(2.94e-06)			(1.30e-06)	
GPR Threat			-5.00e-06			2.48e-06
			(5.50e-06)			(2.45e-06)
N	21 914	21 914	21 914	21 848	21 848	21 848

Notes: Numbers represent the coefficients and standard errors in parentheses. The significance values are as following: 10 %=* and 5 % = **. N stands for number of observations.

Table 5 above shows six regression models separately for selected developed and emerging countries. As the theoretical framework of this thesis presented, the UIP deviation that can be also called as currency risk premium can be affected by rare disaster risk (Zhou et al., 2021). For developed countries the results indicate that UIP deviation is not statistically affected by the changes in GPR indices. However, the coefficients are negative in all cases for developed countries, which indicates that when the GPR indices change it decreases UIP deviations. On the other hand, the general GPR index as well as GPR index with attack indicator show statistically significant results for emerging countries at 5 % and at 10 % levels respectively. These results represent unique evidence that among selected emerging countries the UIP deviation, in other words the currency risk premium, is affected by the general GPR index as well as the GPR index with attacks indicator. The coefficients in every case are positive. This indicates that when the geopolitical risk increases, it leads to increase in UIP deviations and local currency risk premiums in selected emerging countries. Thus, the selected emerging countries' currency pairs depreciate.

Table 5 points out interesting result that the GPR index with threat indicator does not show statistically significant results. In other words, this can indicate that only geopolitical risks that take place, affect to UIP deviation. Zhou et al. (2021) found similar results when they investigated Covid-19 effect on UIP deviations: the UIP deviation increased in case of emerging countries and decreased in case of developed countries.

Based on the results, it can be concluded that among selected developed countries the GPR indices do not reflect the rare disaster risk whereas among selected emerging countries the first two indices reflect the rare disaster risk. The results also show first evidence that the changes in geopolitical risk can cause different effects between selected emerging and developed countries.

5.2 Event study results

This section describes the results from event study and, in addition, builds the core for the empirical analysis with forming the possible abnormal returns for selected exchange rates. With event study estimations the aim is to answer the second sub-question does the terror attacks create abnormal or cumulative abnormal returns for selected currency pairs. Event study was conducted for each currency pair differently and for each selected terror attack. However, the results for each terror attack for all currency pairs are not represented: only the terror attacks that are related to the specific currency pair are represented. To investigate the possible spill over effects, results for attacks in United States are reported for all currency pairs. Both abnormal and cumulative abnormal for several set of days were estimated. However, the results represented in this section include event day abnormal returns as well as cumulative abnormal returns for two days.

The four-day CAR did not show statistically significant results for any currency pair: thus, the results for this are not represented in this thesis. However, when analysing the two-day CAR, it is also possible to see are the abnormal returns only short-term. Table 6 on the next page shows the estimated results for each terror attack. More specific list of the events can be seen in Appendix 1.

The results are interesting and in addition, show some evidence that differs from previous research. In case of 9/11 only CHF and NOK show statistically significant and negative results for event day. In case of all other currencies the results are not statistically significant. In addition, in case of CHF and NOK the effect is no longer significant in two-day CAR. Nikkinen et al. (2006) also studied 9/11 on stock markets and concluded that the effect was larges in case of integrated economies. This can explain the results for CHF as well as for NOK, but on the other hand, for example EUR did not show statistically significant results. Another terror attack that took place in United States, Boston marathon bombing, does not show any statistically significant results for any of the currencies. Hassapis et al. (2018) who studied Japanese yen (YEN), GBP, EUR, and CHF, made similar findings in case of Boston Marathon Bombings.

For developed countries' currencies, corresponding terror attacks show interesting results. Abnormal returns for CHF indicate strongly that terror attacks do not cause the currency pair to move. This can indicate a possibility for safe haven which findings by Hassapis et al. (2018) and Markoulis (2021) also support: in other words, only in case of 9/11 the coefficient for CHF was negative and statistically significant for the event day. Moreover, Balcilar et al. (2017) investigated that this kind of safe havens can cause capital fluctuations.

For London Bombings in 2005, the results show that GBP have a negative and statistically significant coefficient at 10 % level for two-day CAR. However, the effect remains small and only short-term. The other attack that took place in Westminster bridge in United Kingdom, does not seem to have statistically significant effect on GBP: however, the effect remains negative. What is noteworthy among developed countries is that terror attacks that took place in France, often affect additionally to other countries. For example, GBP shows negative and significant results at 10 % level for terror attack in France in 2016. Also, some emerging countries currency pairs, such as RUB and ZAR are statistically significant and negative in case of terror attack in France. However, the effect can be seen on event day and on two-day CAR, which indicates that the effect can last longer than the event day itself. Thus, this also highlights the importance of investigate the next trading days. All in all, on explanation for the spread of the effect can be integrated market areas as Chen and Siems (2004) indicates in their research.

Table 6. Event study results for AR and CAR2 returns for the selected exchange rates.

	AR								CAR2							
Event / Currency pair	*EURUSD*	*CHFUSD*	*NOKUSD*	*GBPUSD*	*BRLUSD*	*INRUSD*	*RUBUSD*	*ZARUSD*	*EURUSD*	*CHFUSD*	*NOKUSD*	*GBPUSD*	*BRLUSD*	*INRUSD*	*RUBUSD*	*ZARUSD*
11/09/2001	-0.0107	-0.0200	-0.026	-0.0115	-0.0047	0.0012	-0.0001	0.0154	-0.0060	-0.0139	-0.0139	-0.0036	0.0018	-0.0001	-0.0000	0.0161
	-1.3007	-2.1954**	-2.4790**	-1.3995	-0.3986	0.2341	-0.0093	1.0534	-0.5109	-1.0812	-0.9246	-0.3095	0.1077	-0.0145	-0.0022	0.7825
27/09/2001		-0.0016								0.0016						
		-0.1746								0.1251						
01/10/2001						0.0031								0.0046		
						0.6070								0.6293		
01/08/2003					-0.0226		0.0028						0.0430		0.0032	
					-1.9142*		0.2524						2.5762***		0.2091	
06/02/2004							0.0011								0.0030	
							0.0990								0.1922	
31/08/2004							0.0015								0.0008	
							0.1368								0.0539	
07/07/2005				0.0066								0.0206				
				0.7992								1.7658*				
07/07/2006					0.0030								-0.0064			
					0.2556								-0.3811			
11/07/2006						-0.0010								-0.0009		
						-0.1991								-0.1183		
13/05/2008						-0.0064								-0.0056		
						-1.2374								-0.761		
26/11/2008					-0.0165	-0.0093							-0.0039	-0.0212		
					-1.4022	-1.8010*							-0.2331	-2.9115***		
27/11/2009							0.0044								0.0065	
							0.3968								0.4212	
22/07/2011			-0.0007								0.0090					
			-0.0678								0.5982					
15/04/2013	0.0045	0.0041	-0.0003	0.0024	0.0060	0.0083	0.0096	0.0155	-0.0057	-0.0042	-0.0089	-0.0000	-0.0014	0.0025	0.0014	0.0174
	0.5499	0.4534	-0.0299	0.2877	0.5048	1.6098	0.8744	1.0657	-0.4883	-0.3231	-0.5924	-0.0025	-0.0820	0.3456	0.0916	0.8422
06/08/2014						0.0128								0.0105		
						2.4847**								1.4356		
13/11/2015	0.0008			0.0007			0.0166		-0.0041			0.0013			0.0335	
	0.0939			0.0908			1.5165		-0.3514			0.1130			2.1554**	
14/07/2016	-0.0032			-0.0144				-0.0270	-0.0006			-0.0040				-0.0139
	-0.3832			-1.7499*				-1.8495*	-0.0531			-0.3406				-0.6736
21/03/2017				-0.0096								-0.0052				
				-1.1686								-0.4472				
22/05/2017				-0.0021								-0.0018				
				-0.2558								-0.1514				
23/03/2018	0.0024								-0.0081							
	0.2899								-0.6911							
14/06/2018								-0.0056								-0.0070
								-0.3810								-0.3373
11/12/2018					0.0154								-0.0112			
					1.3092								-0.6701			

Notes: Numbers represent the value of coefficient and numbers below them represent the t-test results. The significance levels are as following: 1%=***, 5%=** and 10%=*. The abbreviations for currencies can be seen from table 1. The event days are more specifically explained in Appendix 1

.

For emerging countries' currency pairs, the selected terror attacks show also interesting results. Among emerging countries, the spill over effects are also possible. For example, attack in South Africa in 2014 show results on INR that on event day there are abnormal returns that are significant and positive. This can indicate that terror attacks can cause some related country currency to strengthen whereas some other currency depreciates. Same thing can be seen in case of large terror attack in India 2008. Other returns are positive while for INR the effect in steeply negative and statistically significant both for event day returns and two-day CAR. This specific attack especially caused the tourism in India move downward so the effect on currency markets was also evitable (Gunasekar et al., 2018).

The results of the event study vary between attacks and selected currency pairs. Moreover, the results show that currency pairs can depreciate as well as appreciate in case of a terror attacks. These results are also supported by previous literature (see e.g., Narayan et al., 2018). Statistically significant results can be seen for developed as well as emerging countries: however, the results remain rather small as well as short-term in both cases. Based on the estimations, terror attacks cause returns to be negative on average, but the effect is small and short both in developed and emerging currency pairs. Previous research by Markoulis (2021) also highlights that individual events such as terror attacks do not normally cause large abnormal returns on markets. Thus, these findings support the findings of previous research by concluding that terror attacks can cause short-term abnormal return on currency pairs if even those. However, the results also indicate that it is more usual that the emerging countries' currencies are affected by the terror attacks because they show more often statistically significant results.

Also, it is important to notice that possible spill over effects can be seen between developed and emerging countries as terror attacks that took place in Europe cause also statistically significant results to emerging countries' currency pairs. Chen and Siems (2004) concluded in their research that spill over effect are possible where market areas are highly integrated. In the line with the findings from the first empirical model, the results from event study show that exchange rates of selected emerging countries are more easily affected. This, in addition means that in case of terror attacks, it is possible that exchange rate depreciates whereas in developed countries the exchange rates remain quite steady or at least the effect is very short for the currency markets. Similar results were found by Mnasri and Nechi (2016) and Bloomberg et al. (2004).

To investigate terror attacks that took place in United States more deeply, figures 7 and 8 are represented below. Figure 7 represents the abnormal results for 9/11 and the figure 8 shows abnormal results around the Boston Marathon Bombing in United States 2013. Both terror attacks have drawn lot of media attention, and the consequences have been massive in terms of fatal and non-fatal casualties and the property damages. The graphs describe the abnormal returns with event window between -4, event day, and +4 for selected developed and emerging countries separately.

Figure 7 shows interesting results. Whereas in general the emerging countries seem to be more affected by the terror attacks, 9/11 caused massive effects on developed countries. Naturally 9/11 is special for its catastrophic size but the results above all highlight that terror attacks are real threat also for stable markets and economies. The effect of 9/11 can be also explained by the very highly integrated markets as well as anxiety that the large terror attacks created among investors. Hon et al. (2004) investigated 9/11 effects on stock markets and found similar results there: the contagion effect in case of large disasters is inevitable and especially US and European markets are closely related. However, as the Figure 7 indicates the effect on exchange rates is not long term. On the second day from the attacks the abnormal returns are positive.

Figure 7. Abnormal returns around the 9/11.

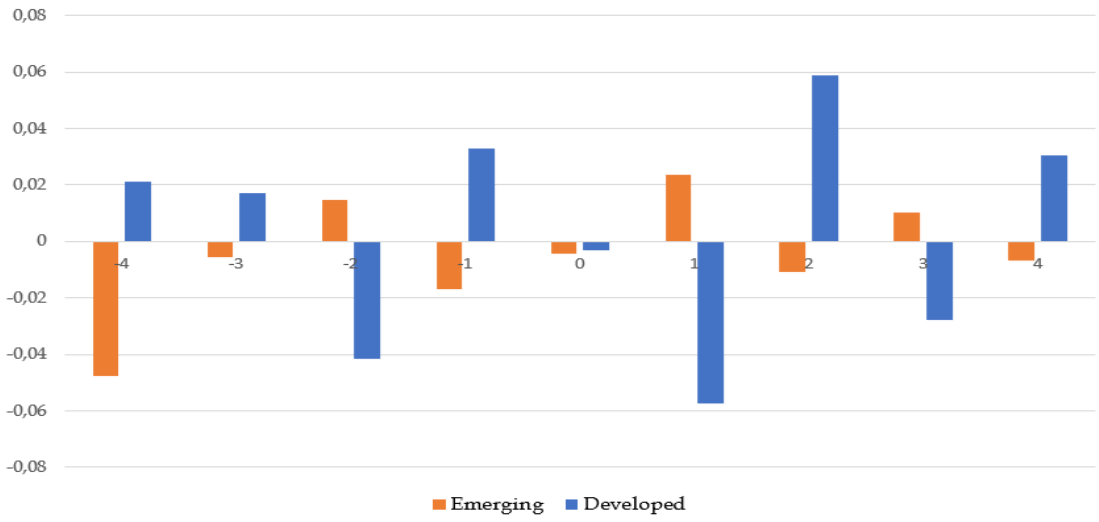


Figure 8. Abnormal returns around the Boston Marathon Bombing.

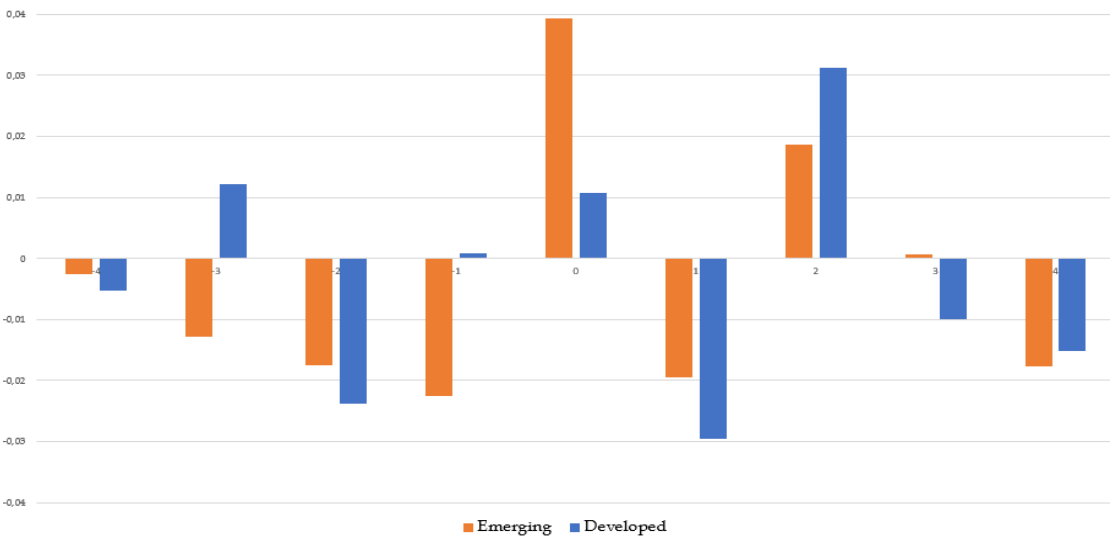


Figure 8 shows that on the following day from the terror attack the abnormal returns were negative both in emerging as well as in developed countries. However, the effects remain small in both cases. Figures 7 and 8 also well highlight that terror attack may cause the exchange rates to depreciate or appreciate, and the effects are not always one way. Whereas the abnormal returns can be seen, figures 7 and 8 also show that the effect is small. Hassapis et al. (2018) conclude similarly in their research that overall financial markets are resilient in case of terror attacks take place. However, it is important to remember that exchange rates can be affected also by other things and thus, the results are multidimensional.

5.3 Results for explanatory variables

The last part of chapter five shows the estimation results for several linear regression models with different sets of explanatory variables. These models aim to answer the third sub-question. The regression models with explanatory variables are divided into two different parts. Tables 7 and 8 show results for currency pair abnormal returns from event day and how the geopolitical risk index dummies affect to the abnormal returns. Geopolitical risk index dummies have been calculated as way that if the index value is larger than the index average it gets value 1, otherwise it is 0. Second part of the results shows the estimations for models 8) and 9) for each currency pair per two-day CAR.

Table 7. Results for developed countries' abnormal returns and geopolitical risk index dummy variables.

Abnormal returns	*EURUSD*	*EURUSD*	*EURUSD*	*CHFUSD*	*CHFUSD*	*CHFUSD*	*GBPUSD*	*GBPUSD*	*GBPUSD*	*NOKUSD*	*NOKUSD*	*NOKUSD*
GPRD_dummy	-0,0058**			-0,0068**			-0,0040			-0,0045		
	(0,0025)			(0,0030)			(0,0028)			(0,0038)		
GPRT_dummy		-0,0012			-0,0016			0,0011			0,0013	
		(0,0028)			(0,0034)			(0,0030)			(0,0039)	
GPRA_dummy			-0,0052**			-0,0072**			-0,0063**			-0,0065*
			(0,0026)			(0,0030)			(0,0027)			(0,0037)
Constant	0,0010	-0,0013	0,0007	0,0018	-0,0007	0,0020	-0,0009	-0,0035	0,0002	0,0012	-0,0018)	0,0022
	(0,0018)	(0,0021)	(0,0018)	(0,0021)	(0,0025)	(0,0021)	(0,0020)	(0,0022)	(0,0019)	(0,0027)	(0,0029)	(0,0026)
R^2	0,2076	0,0081	0,1657	0,2023	0,0113	0,2263	0,0891	0,0068	0,2159	0,0636	0,0056	0,1338
N	22	22	22	22	22	22	22	22	22	22	22	22

Notes: Numbers represent the value of coefficient and numbers in parentheses represent the standard errors. The significance levels are as following: 1%=***, 5%=** and 10%=*. R^2 shows how much the model explains the abnormal returns whereas letter N denotes the number of observations. The abbreviations for currencies can be seen from table 1. GPRD_dummy stands for daily general geopolitical index. GPRT_dummy stands for daily geopolitical index with threat. GPRA_dummy stands for daily geopolitical index with attacks.

Table 7 above shows that currency pairs from developed countries are affected by at least one GPR index dummy. General GPR index on daily level is statistically significant and negative for EUR and CHF. Thus, when the general GPR index is above the average value, it reflects to the abnormal returns of EUR and CHF negatively. In addition, GPR index with attack shows statistically significant as well as negative relationship to all currency pairs in developed countries. Same conclusions as with general GPR index, can be drawn here. Every currency pair abnormal return from developed countries are affected negatively when the GPR index grows extensively above the index average value. However, the GPR index with threat is does not show any statistically significant results in currency pairs.

The GPR indices effect on UIP deviation did not show statistically significant results for developed countries. However, table 7 results indicate that geopolitical risk affects to exchange rate abnormal returns significantly negative. Additionally, according to Caldara and Iacoviello (2022a) market participants see geopolitical risk as part of making the investment decisions on stock markets. Controversially, the results from table 7 show that the exchange rates are statistically affected by changes in geopolitical risk area: thus, the results in FX market differ from results in stock markets.

T**able 8**. Results for emerging countries' abnormal returns and geopolitical risk index dummy variables.

Abnormal returns	*BRLUSD*	*BRLUSD*	*BRLUSD*	*INRUSD*	*INRUSD*	*INRUSD*	*RUBUSD*	*RUBUSD*	*RUBUSD*	*ZARUSD*	*ZARUSD*	*ZARUSD*
GPRD_dummy	-0,0039 (0,0043)			0,0014 (0,0023)			-0,0014 (0,0035)			0,0019 (0,0052)		
GPRT_dummy		0,0009 (0,0044)			0,0036* (0,0022)			0,0006 (0,0036)			0,0043 (0,0051)	
GPRA_dummy			-0,0096** (0,0039)			0,0017 (0,0023)			-0,0053 (0,0033)			-0,0052 (0,0050)
Constant	0,0015 (0,0031)	-0,0009 (0,0033)	0,0043 (0,0027)	-0,0009 (0,0016)	-0,0021 (0,0016)	-0,0010 (0,0016)	-0,0006 (0,0025)	-0,0016 (0,0026)	0,0014 (0,0024)	-0,0006 (0,0037)	-0,0020 (0,0038)	0,0029 (0,0036)
R^2	0,0391	0,0022	0,2362	0,0174	0,1211	0,0267	0,0079	0,0013	0,1137	0,0065	0,0343	0,0506
N	22	22	22	22	22	22	22	22	22	22	22	22

Notes: Numbers represent the value of coefficient and numbers in parentheses represent the standard errors. The significance levels are as following: 1%=***, 5%=** and 10%=*. R^2 shows how much the model explains the abnormal returns whereas letter N denotes the number of observations. The abbreviations for currencies can be seen from table 1. GPRD_dummy stands for daily general geopolitical index. GPRT_dummy stands for daily geopolitical index with threat. GPRA_dummy stands for daily geopolitical index with attacks.

Table 8 above presents the estimation results for selected emerging countries. As opposed to developed countries, the results show that GPR index dummy variables do not affect statistically to abnormal returns of the currency pairs in most cases. The finding is interesting due to GPR indices did show significant results

related to UIP deviation among emerging countries. Furthermore, it is worth noting that most of the coefficients are positive regarding the GPR index dummies. GPR index with threat shows only positive coefficients related to abnormal return. For INR the coefficient is also statistically significant at 10 % level, which could indicate that when GPR threat index is above its average value, it actually has an increasing effect on abnormal return of INR. Thus, it can indicate that INR strengthens against US dollar. Other statistically significant result can be seen in case of GPR attack index in case of BRL. The coefficient is negative which indicates that in case of GPR attack index increases strongly above its average value, it does affect to currency pair abnormal returns negatively.

According to tables 7 and 8, the GPR indices growth above the average value does have stronger effect on developed countries than emerging countries. The R^2, measurement of how much the model explains the dependent variable, also differs between developed and emerging countries. In the case of selected developed countries, the models on average explain more about the abnormal returns of the currency pairs whereas in the case of selected emerging countries the R^2 remains rather small, on average below 0,10.

Based on previous research, these results are unique in their form and reveal new empirical evidence. GPR indices reflect the geopolitical tensions in international relations and thus affect many macroeconomic fundamentals (Caldara and Iacoviello, 2022a). With regards to this, it is natural to find a relationship between abnormal returns and GPR indices especially in developed countries because the financial markets are very integrated and globalized. On the other hand, it is interesting to notice that even if the selected emerging countries, Brazil, Russia, India, and South Africa are also very integrated with themselves, the effect is not significant. One reason for this can be that already in normal situations, the political, economic as well as social atmosphere is more uncertain in emerging countries than in developed countries because of history. As also the figure 2 showed in the beginning of this thesis, amount of terror attacks in selected emerging countries is much higher than in developed countries: thus, terror attacks can be also more anticipated in these emerging countries.

With the intention of investigating more about the abnormal returns, this paper expands the explanatory models with more variables. In addition, the abnormal returns of currency pairs are replaced with cumulative abnormal returns for the event day and next trading day from that. This is due to the fact that the terror attacks could have taken place outside the market trading hours and thus the effect could not be seen until the next trading day. The 22 terror attacks that are selected for this paper have all taken place in trading days and not in weekends.

Table 9 concludes the estimation results for all the selected currency pairs. Due to high correlation variables Wounded and Killed, there are two regression models per each currency pair. Table 9 shows the estimation results for explanatory variables. In each estimation model the number of observations is 22, which equals the number of terror attacks selected for this thesis. For EUR, GPR attack

index dummy is negative however not statistically significant. Also, region dummy is negative but not statistically significant. However, the weapon dummy is statistically significant on 5 % level in both models which shows that in case the terror attack is conducted with explosives it will affect the CAR negatively. One reason for this can be that explosives when take place, can cause massive destruction to infrastructure and a number of fatal and non-fatal casualties. This empirical evidence is also in line with the findings by Markoulis (2021). On the other hand, target dummy and attack dummy the effect is controversial. The coefficients are not statistically significant: the estimations also show positive signs. For EUR, number of killed and wounded people are not significant: coefficient is negative, but the effect remains small.

Estimation models for CHF show that region dummy is statistically significant on 10 % level. This indicates that when a terror attack takes place it will negatively affect a two-day CAR for the CHF. Also, the amount of wounded people shows negative and statistically significant results for CHF at 10 % level. This means that if the terror attack causes non-fatal casualties, it will affect CAR by decreasing it. The results for GBP show that weapon dummy is statistically significant and negative at 10 % level in both models: this indicates the same effect to CAR than with EUR. Attack dummy shows also significant relationship in both models but controversial to expectations, the coefficient sign in positive. This reveals interesting results that in case the attack in bombing, it positively affects currency pair two-day CAR.

As opposed to EUR, CHF, and GBP, for NOK any explanatory variable is not statistically significant and thus, the CAR is not affected by the selected explanatory variables. This can indicate that in case of terror attacks, NOK is able to maintain its stability and not affect statistically significant impacts on returns. On the other hand, this can give a possible safe haven status for NOK due to its stable return even in the case of terror attack.

Table 9 also shows results for selected emerging countries' currency pairs. These models do not include the GPR attack dummy due to table 8 shows that the geopolitical risk indices do not have an effect to abnormal returns of the currency pairs. Overall, the explanatory regression models for emerging countries reveal that only models for INR are affected by some of the explanatory variables. Weapon dummy coefficient is negative and statistically significant which indicates that when the terror attack is conducted with explosives, the CAR is negatively affected for the INR. In addition, attack dummy is statistically significant but reveals interesting findings: the coefficient is positive.

Regression models for explanatory variables, estimation results show that the two-day CAR for selected currency pairs in developed as well as in emerging countries can be affected. However, the selected explanatory variables seem to better explain the two-day CAR for developed countries. For example, the characteristics of terror attacks play a bigger part among developed countries' than in emerging countries' currency pairs. The target dummy (private citizens) does not affect returns against expectations. On the other hand, bombings conducted with explosives as weapons give an impression based on the estimation results

that this kind of terror attack creates uncertainty and fear causing the two-day CAR to change. Estimations also revealed positive coefficients. One explanation for this can be that terror attacks, even if happening rarely, are a threat that has a possibility to happen. In other words, the currency pair returns can already consider the tensions and possibility for drastic terror attack. Markoulis (2021) found similar conclusions.

Table 9. Estimation results for two-day CAR of selected currency pairs and explanatory variables.

CAR2	*EURUSD*	*EURUSD*	*CHFUSD*	*CHFUSD*	*NOKUSD*	*NOKUSD*	*GBPUSD*	*GBPUSD*	*BRLUSD*	*BRLUSD*	*RUBUSD*	*RUBUSD*	*INRUSD*	*INRUSD*	*ZARUSD*	*ZARUSD*
GPR_attack	-0.0028	-0.0026	-0.0030	-0.0028	-0.0037	-0.0034	-0.0051	-0.0050								
	(0.0034)	(0.0033)	(0.0030)	(0.0029)	(0.0040)	(0.0040)	(0.0036)	(0.0037)								
Region_dummy	-0.0027	-0.0024	-0.0049*	-0.0045	-0.0032	-0.0028	0.0020	0.0021	0.0019	0.0018	0.0044	0.0044	-0.0013	-0.0013	0.0142	0.0140
	(0.0034)	(0.0034)	(0.0030)	(0.0030)	(0.0041)	(0.0042)	(0.0037)	(0.0038)	(0.0061)	(0.0061)	(0.0055)	(0.0055)	(0.0028)	(0.0029)	(0.0053)	(0.0053)
Weapon_dummy	-0.0114**	-0.0118**	-0.0055	-0.0061	-0.0049	-0.0056	-0.0102*	-0.0101*	0.01039	0.0108	0.0018	0.0017	-0.0095 **	-0.0099 **	-0.0016	-0.0010
	(0.0051)	(0.0050)	(0.0046)	(0.0045)	(0.0062)	(0.0061)	(0.0057)	(0.0056)	(0.0094)	(0.0094)	(0.0084)	(0.0084)	(0.0043)	(0.0044)	(0.0082)	(0.0082)
Target_dummy	0.0005	0.0005	0.0008	0.0001	-0.0033	-0.0032	-0.0018	-0.0017	0.0043	0.0045	-0.0010	-0.0014	0.0031	0.0026	0.0013	0.0015
	(0.0042)	(0.0041)	(0.0037)	(0.0036)	(0.0050)	(0.0050)	(0.0046)	(0.0045)	(0.0082)	(0.0081)	(0.0073)	(0.0072)	(0.0037)	(0.0038)	(0.0071)	(0.0071)
Attack_dummy	0.0049	0.0053	0.0020	0.0026	-0.0026	-0.0019	0.0134***	0.0134***	0.0048	0.0044	-0.0003	-0.0000	0.0091 **	0.0095 **	0.0101	0.0093
	(0.0046)	(0.0045)	(0.0041)	(0.0040)	(0.0056)	(0.0055)	(0.0050)	(0.0050)	(0.0087)	(0.0086)	(0.0076)	(0.0077)	(0.0040)	(0.0040)	(0.0075)	(0.0075)
Killed	-5.29e-06		-7.52e-06		-8.72e-06		3.17e-07		40.27e-06		-20.78e-06		-40.32e-06		70.12e-06	
	(5.39e-06)		(4.80e-06)		(6.52e-06)		(5.94e-06)		(0.0000)		(90.16e-06)		(40.74e-06)		(80.95e-06)	
Wounded		-7.60e-07		-1.07e-06*		-1.19e-06		-5.15e-08		40.75e-07		-90.95e-08		80.53e-07		80.53e-07
		(6.93e-07)		(6.11e-07)		(8.39e-07)		(7.69e-07)		(10.32e-06)		(10.18e-06)		(10.15e-06)		(10.15e-06)
Constant	0.0072	0.0069	0.0057	0.0053	0.0092	0.0088	0.0021	0.0020	-0.0101	-0.0099	-0.0019	-0.0021	0.0015	0.0013	-0.0097	-0.0094
	(0.0041)	(0.0041)	(0.0037)	(0.0036)	(0.0050)	(0.0050)	(0.0045)	(0.0046)	(0.0063)	(0.0063)	(0.0057)	(0.0057)	(0.0029)	(0.0029)	(0.0055)	(0.0055)
R^2	0,356	0,3656	0,3621	0,3832	0,3159	0,3251	0,3533	0,3534	0,2500	0,2479	0,0516	0,0466	0,3824	0,3596	0,3895	0,3864
N	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22	22

Notes: Numbers represent the value of coefficient and numbers in parentheses represent the standard errors. The significance levels are as following: 1%=***, 5%=** and 10%=*. R^2 shows how much the model explains the abnormal returns whereas letter N denotes the number of observations. The abbreviations for currencies can be seen from table 1. The explanatory variable abbreviations are as following. GPR_attack represents the GPR threat index dummy. Region_dummy represents a dummy variable where 1 stands for developed countries and 0 for emerging countries. Weapon_dummy represents a dummy variable where 1 equals explosive and 0 other weapons used in attacks. Target_dummy represents a dummy variable where 1 equals private citizens and 0 other target types used in attacks. Attack_dummy represents a dummy variable where 1 equal bombing and 0 other attack types used in attacks. Variables Killed and Wounded stands for the amount of non-fatal and fatal casualties by selected terror attacks.

6 CONCLUSION

The aim of this thesis was to investigate the relationship between exchange rates and terror attacks in selected emerging and developed countries. The set of emerging countries included the BRICS countries excluding China because of its pegged exchange rate. The set of developed countries included United Kingdom, Norway, Switzerland, and France. The corresponding currencies of these selected countries are investigated responding to terror attacks that took place in these countries between the years 2000 and 2020. In total 22 terror attacks were selected. In addition, these 22 attacks include two terror attacks from United States in order to investigate possible spill over effects. The intention of this thesis stems from controversial as well as scarce results between exchange rates and terror attacks. Especially this thesis aimed to show the different reactions between emerging and developed countries currency pairs in case of catastrophic terror attacks and geopolitical tensions in terms of terrorism.

The main research question of this thesis is as following: How do terror attacks affect exchange rates in selected developed and emerging countries? This thesis investigated the mutual relationship between exchange rates and terror attacks from three different perspectives with three different sub-research questions. The first sub-question investigates the relationship between UIP deviation which can be also as currency risk premium and geopolitical risk indices in terms of terrorism. The results show first signs that the emerging countries' currency pairs are more affected by the geopolitical tensions than developed countries. Moreover, the results also indicated that in case of emerging countries the currencies depreciate and in developed countries the currencies appreciate. Thus, changes in geopolitical risk can cause diverse effects on exchange rates.

The second sub-question forms the empirical base for the whole analysis. With event study results, this thesis is able to show how abnormal returns as well as two-day cumulative abnormal returns (CAR) indicate that the effect of terror attack is there but only short-term. More interestingly, the effects vary between developed and emerging countries as also in the first empirical model. The event

study results conclude that according to constructed hypotheses of this thesis, emerging countries currency pairs are more often affected by the terror attack negatively which on the other hand, causes the currencies to depreciate whereas in developed countries the effect remains small. Results, in addition, indicate the possibility of safe havens due to event study results shows that Swiss franc remains rather steady and do not show statistically significant results excluding 9/11.

The third sub-question aims to describe the explanatory variables more closely for abnormal returns as well as for two-day CAR. The results indicate that selected variables are better able to explain the two-day CAR among developed countries. Thus, this shows that the terror attack itself and its characteristics, for example its consequences for humans affect the two-day CAR of exchange rates. However, among emerging countries, the characteristics of terror attack or its consequences do not seem to have statistically significant effects.

With above mentioned three sub-questions, this thesis is able to answer to the main research question how the terror attacks affect to selected exchange rates. Based on empirical evidence, terror attacks can cause exchange rates to depreciate or appreciate. The effect is short-term in selected developed as well as in emerging countries, but according to results, emerging countries are more reactive to terror attacks. These results are also supported by previous empirical findings. With the findings of this thesis, for developed countries the formed null hypothesis can be accepted: the empirical evidence shows that terror attacks effect on exchange rates remains small. On the other hand, the null hypothesis for emerging countries can also be accepted due to statistically significant results for emerging countries' currency pairs can be seen in estimated models. The empirical findings discovered in this thesis additionally show that at least among selected emerging countries the term rare disaster can be used when talking about terrorism and terror attacks as geopolitical risk.

While this thesis provides unique information related to relationship between exchange rates and terror attacks by examining the UIP deviation and geopolitical risks in terms of terrorism, abnormal returns and explanatory variables, many questions can be kept unanswered as the conclusion remains multidimensional. However, it is good to remember that this thesis also bears some limitations. For instance, in empirical models the sample size could be larger in order to get more precise results. In addition, the UIP deviation is investigated only in eight countries and the explanatory variable regression models show results for only 22 observations (terror attacks). Above all, it is essential to remember that all the 22 terror attacks are investigated separately assuming that one terror attack is not affected by any other terror attack. In real life, however, several terror attacks can take place during short period of time in the same area and consequently, affect to results. This can, on one hand, create biased results. In addition, exchange rates can be affected by economical and/or other factors that are not represented in this thesis.

For further research, these limitations could be considered. In addition, it could be interesting investigate larger set of developed and emerging countries

with relative to geopolitical risk indices in terms of terrorism. It could also be interesting to develop a separate index for terror attacks based on country's history, ongoing development, economic situation and future prospectives and see how much the geopolitical risk indices actually cover terror attacks.

REFERENCES

Abadie, A., & Gardeazabal, J. (2008). Terrorism and the world economy. *European Economic Review, 52*(1), 1-27. https://doi.org/10.1016/j.euroecorev.2007.08.005

Arin, K. P., Ciferri, D., & Spagnolo, N. (2008). The price of terror: The effects of terrorism on stock market returns and volatility. *Economics Letters, 101*(3), 164-167. https://doi.org/10.1016/j.econlet.2008.07.007

Balcilar, M., Gupta, R., Pierdzioch, C., & Wohar, M. E. (2017). Do terror attacks affect the dollar-pound exchange rate? A nonparametric causality-in-quantiles analysis. *The North American Journal of Economics and Finance*, 41, 44-56. https://doi.org/10.1016/j.najef.2017.03.010

Bank of International Settlements. (27.10.2022). OTC foreign exchange turnover in April 2022. Retrieved November, 11, 2022, from https://www.bis.org/statistics/rpfx22_fx.htm

Barro, R. J. (2006). Rare Disasters and Asset Markets in the Twentieth Century. *The Quarterly Journal of Economics, 121*(3), 823-866. https://doi.org/10.1162/qjec.121.3.823

Berkman, H., Jacobsen, B., & Lee, J. B. (2011). Time-varying rare disaster risk and stock returns. *Journal of Financial Economics, 101*(2), 313-332. https://doi.org/10.1016/j.jfineco.2011.02.019

Blomberg, S., Hess, G. D., & Weerapana, A. (2004). Economic conditions and terrorism. *European Journal of Political Economy, 20*(2), 463-478. https://doi.org/10.1016/j.ejpoleco.2004.02.002

Caldara, D., & Iacoviello, M. (2022a). Measuring Geopolitical Risk. *The American Economic Review, 112*(4), 1194-1225. https://doi.org/10.1257/aer.20191823

Caldara, D., & Iacoviello, M. (2022b). Measuring Geopolitical Risk. *The American Economic Review, 112*(4), 1194-1225. Data downloaded from https://www.matteoiacoviello.com/gpr.htm on 13.12.2022.

Chen, A. H., & Siems, T. F. (2004). The effects of terrorism on global capital markets. *European Journal of Political Economy, 20*(2), 349-366. https://doi.org/10.1016/j.ejpoleco.2003.12.005

Coombs, W. T. (1995). Choosing the Right Words: The Development of Guide lines for the Selection of the "Appropriate" Crisis-Response Strategies. *Management Communication Quarterly*, 8(4), 447-476. https://doi.org/10.1177/0893318995008004003

Delcoure, N., Barkoulas, J., Baum, C. F., & Chakraborty, A. (2003). The forward rate unbiasedness hypothesis reexamined: Evidence from a new test. *Global Finance Journal, 14*(1), 83-93. https://doi.org/10.1016/S1044-0283(03)00006-1

Eckstein, Z., & Tsiddon, D. (2004). Macroeconomic consequences of terror: Theory and the case of Israel. *Journal of Monetary Economics*, 51(5), 971-1002. https://doi.org/10.1016/j.jmoneco.2004.05.001

Eldor, R., & Melnick, R. (2004). Financial markets and terrorism. *European Journal of Political Economy, 20*(2), 367-386. https://doi.org/10.1016/j.ejpoleco.2004.03.002

Elnahass, M., Marie, M., & Elgammal, M. (2022). Terrorist attacks and bank financial stability: Evidence from MENA economies. *Review of Quantitative Finance and Accounting*, 59(1), 383-427. https://doi.org/10.1007/s11156-022-01043-1

Enders, W., Sachsida, A., & Sandler, T. (2006). The Impact of Transnational Terrorism on U.S. Foreign Direct Investment. *Political Research Quarterly*, 59(4), 517-531. https://doi.org/10.1177/106591290605900402

Estrada, M. A. R., Park, D., Kim, J. S., & Khan, A. (2015). The economic impact of terrorism: A new model and its application to Pakistan. *Journal of Policy Modeling, 37*(6), 1065-1080. https://doi.org/10.1016/j.jpolmod.2015.08.004

Europol. (14.7.2022). EU Terrorism Situation & Trend Report (TE-SAT). Retrieved October, 12, 2022, from https://www.europol.europa.eu/publications-events/main-reports/tesat-report

Fama, E. F., Fisher, L., Jensen, M. C., & Roll, R. (1969). The Adjustment of Stock Prices to New Information. *International Economic Review (Philadelphia), 10*(1), 1-21. https://doi.org/10.2307/2525569

Fama, E. F. (1970). Efficient Capital Markets: A Review of Theory and Empirical Work. *The Journal of Finance (New York), 25*(2), 383. https://doi.org/10.2307/2325486

Farhi, E. & Gabaix, X. (2016). RARE DISASTERS AND EXCHANGE RATES. *The Quarterly Journal of Economics*, 131(1), 1-52. https://doi.org/10.1093/qje/qjv040

Federal Bureau of Investigations. (no date). What we investigate. Retrieved September 22, 2022, from https://www.fbi.gov/investigate/terrorism

Global Terrorism Database 1970 – 2020. (2022). START (National Consortium for the Study of Terrorism and Responses to Terrorism). [data file]. Retrieved September 11, 2022, from https://www.start.umd.edu/gtd

Gujarati, D. (2011). Econometrics by Example. Palgrave Macmillan.

Gunasekar, S., Patri, R., & Narayanan, B. (2018). International Tourist Arrival in India: Impact of Mumbai 26/11 Terror Attack. *Foreign Trade Review (New Delhi), 53*(1), 12-28. https://doi.org/10.1177/0015732516681882

Gupta, R., Suleman, T., & Wohar, M. E. (2019). Exchange rate returns and volatility: The role of time-varying rare disaster risks. *The European Journal of Finance, 25*(2), 190-203. https://doi.org/10.1080/1351847X.2018.1534750

Hassapis, K., Katsikidis, S., and Markoulis, S. (2019). Terror At tacks, Foreign Exchange Markets, and Class Dynamics. London: IntechOpen, pp. 55–75. http://dx.doi.org/10.2139/ssrn.3215773

Hasso, T., Pelster, M., & Breitmayer, B. (2020). Terror attacks and individual investor behavior: Evidence from the 2015–2017 European terror attacks. *Journal of Behavioral and Experimental Finance, 28*, 100397. https://doi.org/10.1016/j.jbef.2020.100397

Hoffman, B. (2006). *Inside terrorism*. https://doi.org/10.7312/hoff12698

Hon, M. T., Strauss, J., & Yong, S. (2004). Contagion in financial markets after September 11: Myth or reality? *The Journal of Financial Research, 27*(1), 95-114. https://doi.org/10.1111/j.1475-6803.2004.00079.x

International Monetary Fund. (1.4.2021). Managing divergent recoveries. Retrieved November, 19, 2022, from https://www.imf.org/en/Publications/WEO/Is sues/2021/03/23/world-economic-outlook-april-2021

Institute for Economics & Peace. (2022). Global Terrorism Index 2022: Measuring the Impact of Terrorism. Retrieved October, 13, 2022, from http://visionofhumanity.org/resources

Iqbal, B., A. (2022). BRICS as a Driver of Global Economic Growth and Development. *Global Journal of Emerging Market Economies*, 14(1), 7-8. https://doi.org/10.1177/09749101211067096

Javaid, M. E., & Kousar, S. (2018). Impact of Terrorism, Political System and Exchange Rate Fluctuations on Stock Market Volatility. *Iranian Journal of Management Studies, 11*(3), 519-545. https://doi.org/10.22059/ijms.2018.251471.673006

Johnston, R. B., & Nedelescu, O. M. (2006). The impact of terrorism on financial markets. *Journal of Financial Crime*, 13(1), 7-25. https://doi.org/10.1108/13590790610641233

Kaplanski, G., & Levy, H. (2010). Sentiment and stock prices: The case of aviation disasters. *Journal of Financial Economics*, 95(2), 174-201. https://doi.org/10.1016/j.jfineco.2009.10.002

Keynes, J. (1920). The Economic Consequences of the Peace. Harcourt, Brace, and Howe.

Krugman P. (2004). The costs of terrorism: What do we know? *The Princeton Project on National Security*.

Kumar, S., & Liu, J. (2013). Impact of Terrorism on International Stock Markets. *The Journal of Applied Business and Economics, 14*(4), 42.

Lenain, P., Bonturi, M., & Koen, V. (2002). *The Economic Consequences of Terrorism*. https://doi.org/10.1787/511778841283

Ma, F., Lu, F., & Tao, Y. (2022). Geopolitical risk and excess stock returns predictability: New evidence from a century of data. *Finance Research Letters, 50*, 103211. https://doi.org/10.1016/j.frl.2022.103211

MacKinlay, A. C. (1997). Event Studies in Economics and Finance. *Journal of Economic Literature*, 35(1), 13-39.

Maitah, M., Mustofa, J., & Ugur, G. (2017). The Impact of Terrorist Attacks on Foreign Exchange Rate: Case Study of Turkish Lira versus Pound Sterling. *Economies, 5*(1), 5. https://doi.org/10.3390/economies5010005

Markoulis, S. (2021). Do Terror Attacks Affect the Euro? Evidence from the 21st Century. *Journal of Risk and Financial Management*, 14(8), 349. https://doi.org/10.3390/jrfm14080349

Mnasri, A., & Nechi, S. (2016). Impact of terrorist attacks on stock market volatility in emerging markets. *Emerging Markets Review, 28*, 184-202. https://doi.org/10.1016/j.ememar.2016.08.002

Narayan, P. K., Narayan, S., Khademalomoom, S., & Phan, D. H. B. (2018). DO TERRORIST ATTACKS IMPACT EXCHANGE RATE BEHAVIOR? NEW INTERNATIONAL EVIDENCE: TERRORIST ATTACKS AND EXCHANGE RATE BEHAVIOR. *Economic Inquiry, 56*(1), 547-561. https://doi.org/10.1111/ecin.12447

Nikkinen, J., Omran, M. M., Sahlström, P., & Äijö, J. (2008). Stock returns and volatility following the September 11 attacks: Evidence from 53 equity markets. *International Review of Financial Analysis, 17*(1), 27-46. https://doi.org/10.1016/j.irfa.2006.12.002

Nilsen, M., Albrechtsen, E., & Nyheim, O. M. (2018). Changes in Norway's societal safety and security measures following the 2011 Oslo terror attacks. *Safety Science, 110*, 59-68. https://doi.org/10.1016/j.ssci.2017.06.014

Office of the United Nations High Commissioner for Human Rights. (no date). Human rights, terrorism and counter-terrorism. Retrieved September, 22, 2022, from https://www.ohchr.org/sites/default/files/Documents/Publications/Factsheet32EN.pdf

Papakyriakou, P., Sakkas, A., & Taoushianis, Z. (2019). The impact of terrorist attacks in G7 countries on international stock markets and the role of investor sentiment. *Journal of International Financial Markets, Institutions & Money, 61*, 143-160. https://doi.org/10.1016/j.intfin.2019.03.001

Park, C., & Park, S. (2020). Rare disaster risk and exchange rates: An empirical investigation of South Korean exchange rates under tension between the two Koreas. *Finance Research Letters, 36*, 101314. https://doi.org/10.1016/j.frl.2019.101314

Rabitsch, K. (2016). An Incomplete Markets Explanation of the Uncovered Interest Rate Parity Puzzle. *Review of International Economics, 24*(2), 422-446. https://doi.org/10.1111/roie.12220

Rietz, T. A. (1988). The equity risk premium a solution. *Journal of Monetary Economics*, 22(1), 117-131. https://doi.org/10.1016/0304-3932(88)90172-9

Shahzad, S. J. H., Kyei, C. K., Gupta, R., & Olson, E. (2021). Investor sentiment and dollar-pound exchange rate returns: Evidence from over a century of data using a cross-quantilogram approach. *Finance Research Letters, 38*, 101504. https://doi.org/10.1016/j.frl.2020.101504

Sharma, S. S., Bach Phan, D. H., & Narayan, P. K. (2019). Exchange rate effects of US government shutdowns: Evidence from both developed and emerging markets. *Emerging Markets Review, 40*, 100626. https://doi.org/10.1016/j.ememar.2019.100626

Slovic, P. (1987). Perception of Risk. Science (American Association for the Advancement of Science), 236(4799), 280-285. https://doi.org/10.1126/science.3563507

Ullah, S., Zaefarian, G., Ahmed, R., & Kimani, D. (2021). How to apply the event study methodology in STATA: An overview and a step-by-step guide for authors. *Industrial Marketing Management, 99*, A1-A12. https://doi.org/10.1016/j.indmarman.2021.02.004

Wang, A. Y., & Young, M. (2020). Terrorist attacks and investor risk preference: Evidence from mutual fund flows. *Journal of Financial Economics, 137*(2), 491-514. https://doi.org/10.1016/j.jfineco.2020.02.008

Zhou, H., Yu, M., Li, J. & Qin, Q. (2021). Rare disasters, exchange rates, and macroeconomic policy: Evidence from COVID-19. *Economics Letters*, 209, 110099. https://doi.org/10.1016/j.econlet.2021.110099

APPENDIX 1: Selection of terror attacks.

Time	Country	Region	Wounded	Killed	Property damage	Attack type	Target type	Weapon type
11/09/2001	United States	North America	10878	1385	Catastrophic	Hijacking	Private Citizens	Vehicle
27/09/2001	Switzerland	Western Europe	18	14	Blank	Armed assault	Government	Firearms
01/10/2001	India	SouthAsia	60	31	Major	Bombing	Government	Explosives
01/08/2003	Russia	Eastern Europe	76	40	Major	Bombing	Transportation	Explosives
06/02/2004	Russia	Eastern Europe	122	40	Major	Bombing	Transportation	Explosives
31/08/2004	Russia	Eastern Europe	50	11	Major	Bombing	Transportation	Explosives
07/07/2005	United Kingdom	Western Europe	196	56	Major	Bombing	Transportation	Explosives
07/07/2006	Brazil	South America	11	0	Unknown	Bombing	Transportation	Explosives
11/07/2006	India	South Asia	817	188	Major	Bombing	Transportation	Explosives
13/05/2008	India	South Asia	170	80	Major	Bombing	Religious Figures	Explosives
26/11/2008	India	South Asia	183	252	Unknown	Hostage	Business	Explosives
27/11/2009	Russia	Eastern Europe	100	26	Major	Bombing	Transportation	Explosives
22/07/2011	Norway	Western Europe	60	69	Minor	Armed assault	Private Citizens	Firearms
15/04/2013	United States	North America	132	1	Unknown	Bombing	Private Citizens	Explosives
06/08/2014	South Africa	Sub Saharan	1	3	Minor	Armed assault	Private Citizens	Firearms
13/11/2015	France	Western Europe	217	93	Minor	Hostage	Business	Explosives
14/07/2016	France	Western Europe	433	87	Unknown	Armed assault	Private Citizens	Firearms
21/03/2017	United Kingdom	Western Europe	50	6	Blank	Armed assault	Religious Figures	Melee
22/05/2017	United Kingdom	Western Europe	119	23	Unknown	Bombing	Transportation	Explosives
23/03/2018	France	Western Europe	13	4	Blank	Hostage	Business	Explosives
14/06/2018	South Africa	Sub Saharan	2	3	Blank	Armed assault	Religious Figures	Melee
11/12/2018	Brazil	South Asia	4	5	Blank	Armed assault	Religious Figures	Firearms

Notes: All data is obtained from Global Terrorism Database.

APPENDIX 2: More specific definitions of explanatory variables.

Explanatory variable		Explanation
Wounded		Amount of wounded people in the case of a specific terror attacks
Killed		Amount of killed people in the case of a specific terror attacks
Region		Geographical location of the attack
	Western Europe	From the selected countries used in this paper; France, Switzerland and United Kingdom
	Eastern Europe	From the selected countries used in this paper; Russia
	North America	From the selected countries used in this paper; United States used for spillover effects
	South America	From the selected countries used in this paper; Brazil
	South Asia	From the selected countries used in this paper; India
	Sub Saharan	From the selected countries used in this paper; South Africa
Weapon type		Type on weapon used to conduct the terror attack: Explosives Firearms Melee Vehicle
Attack type		Type of attacks how the terror attack is conducted: Armed assault Bombing Hijacking Hostage
Target type		Type of target on which the terror attack is aimed: Business Private citizens Government Religious figures Transportation

Notes: All data is obtained from Global Terrorism Database by author.

APPENDIX 3: Use of AI based tools in this thesis.

In this thesis ChatGPT AI tool is used to improve the academic language (synonyms and sentence structures) as well as obtain basic information related to empirical analysis.