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SCHOOL OF ECONOMICS AND BUSINESS

MASTER'S THESIS

AN EVENT STUDY OF THE IMPACT OF ECB's AND FED's INTEREST RATE ANNOUNCEMENTS ON STOCK MARKETS PERFORMANCE

Ljubljana, September 2023 Naida Hadžić

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APT - Arbitrage Pricing Theory
AAR - Average Abnormal Returns
AR - Average Residual
CAPM - Capital Asset Pricing Model
CRVE - Cluster-Robust Variance-Covariance Estimator
CMR - Constant-Mean-Return Model
CAAR - Cumulative Average Abnormal Returns
EIA - Energy Information Administration
ECB - European Central Bank
EMS - European Monetary System
FOMC - Federal Open Market Committee
FED - Federal Reserve System
FX - Foreign Exchange
GDP - Gross Domestic Product
IEA - International Energy Agency
MRO - Main Refinancing Operations rate
MSCI - Morgan Stanley Capital International
NYSE - New York Stock Exchange
OMOs - Open Market Operations
OLS - Ordinary Least Squares
SSE - Shanghai Stock Exchange

INTRODUCTION

The year 2022 has been a year full of different events that shook the World's economy even more after the COVID-19 health crisis. Entering the year 2022, the World has still not recovered from one crisis but entered into deepened distress after February 24th, 2022, when the Russian invasion of Ukraine started. Problems started to accumulate and the concerns about recession started to mount (World Bank, 2022). In a globalized society, the problem of one is the problem of all. With the recession around the corner, measures had to be set to combat radical consequences. The World was faced with all different kinds of crises, from humanitarian, and food crisis to economic, financial, and, especially, energy crisis as is presented, in detail, in the "World Energy Outlook 2022" by the International Energy Agency in 2022. Disruption in trade, and insufficient food and energy supply all contributed to price hikes for these goods and inflation started to grow rapidly. Inflation represents an increase in prices of goods and services over a defined period of time (Mankiw, 2017, p. 13). It is a very volatile parameter and it is very hard to control. If the inflation rate is high for a prolonged period of time, it certainly counts as one of the main factors leading towards economic activity downfall, i.e., recession. To prevent the worst-case scenario and keep markets sufficiently stable, central banks had to intervene.

The role of central banks is to conduct monetary policy with the aim of ensuring financial and price stability by using monetary strategies and tools at their disposal. This very thesis focuses on the two central banks and their measures during the 2022 crisis; namely, the European Central Bank and the Federal Reserve System. There are a few reasons why the thesis focuses on these two central banks. The main one is based on the fact that the US dollar and the Euro are, by far, the two most traded currencies in the forex market, especially the US dollar. Another reason comes from my own place of interest since I inhabit a place where the Euro is a common currency. Furthermore, the 2022 crisis has deepened the previous, COVID-19, health crisis due to the Russia-Ukraine war which takes place on European soil leaving immense consequences on European markets and Euro stability. Consequences have dispersed globally and it is of interest to analyse monetary measures undertaken by the European Central Bank and the measures of the World's largest central bank, the Federal Reserve System, by ultimately comparing them. It is, moreover, of my core interest to analyse how their respective monetary measures have influenced the stock markets' performance and how stock prices have been affected. The two central banks are quite enthralling for comparison, since both operate in fairly similar ways. Both use open market operations, as one of the three main monetary policy tools at their disposal, to provide liquidity to markets. By engaging in OMOs, they affect the availability of money and credit.

Direct impact on the supply of the money both have through adjusting their key interest rates. The main threat of the 2022 crisis is shown to be raging inflation (Economist, 2022). In order to stabilize their respective economies, both central banks had to adjust their key interest rates. The year 2022 started with already high inflation; the US economy observed an annual

inflation rate of 7.5% in January 2022 (FRED Statistics, 2022), whereas the euro area hit an annual inflation rate of 5.1% and the European Union 5.6% for the same month (Eurostat, 2022). After the start of the war, inflation continued to grow, but now even more apace. Having a firmly set aim of targeting 2% inflation rate over a medium-term, the situation for both US and EU economies did not seem bright even in January 2022. The new measures had to be set in place to combat further inflation-increasing trends (Financial Times, 2022). The FED started first by raising its federal funds rate in March 2022 (FED Press Release, 2022), and the ECB followed in July 2022 (ECB Press Release, 2022).

The ECB started with the same strategy by raising interest rate on the main refinancing operations, interest rate on the marginal lending facility, and interest rate on the deposit facility. The FED increased the federal funds rate seven times, the ECB increased the rates four times in 2022 (FED and ECB Press Releases, 2022). It is announced that the rates will continue to increase in the year 2023 (Washington Post, 2022). The decision to increase key interest rates was historic, as many journals highlighted in their articles in 2022. As Euronews puts in its articles from the 21st of July 2022, the ECB increased its rates for the first time in the last 11 years and the FED observed the largest price increase from the 1980s. The direct effect on stabilizing the economy from an environment of high inflation starts by increasing key interest rates to affect other short- and long-term interest rates, and foreign exchange rates, slow economic activity, and reduce the money supply, which will as the end-goal push prices back down. The monetary policy announcements, which started in 2022, affected stock markets' movements, where agents were forced to adopt expectations by changing their investment positions adequately.

Stock markets, next to forex markets, are extremely volatile and they react to all information shocks. Both expected and unexpected ones. They represent one of the main indicators of the state of one economy. Without stock markets, it would be impossible for countries to strive for and reach their development goals. To prevent financial market collapse, it is of high importance to adequately respond to market shocks. The volatility of stock markets is found in numerous reasons and events, endogenous and exogenous ones. The biggest problem is found in exogenous, unexpected, events that create the highest deviations of stock prices. Exogenous events can be of a different category, such as the impact of the geopolitical nature, including the war and civil unrest, then inflation and booming of the inflationary environment as is the case in this thesis, all to different natural disasters, terrorism, internal company developments, impact on foreign exchange rates and many others. This thesis firmly focuses on the empirical analysis of the stock markets' movement under exogenous events that occurred in the year 2022 – the COVID-19 residues, the Russia-Ukraine war, raging inflation, and the central banks' key interest rate increases.

The central focus is on the decade-historic key interest rate hikes announced by central banks to prevent the 2008 financial collapse scenario and the impact of these announcements on the stock markets' performance. The empirical analysis of this thesis is based on the event

study methodology. This methodology at its core measures the effect of an event on the value of the chosen and analysed variable(s). In this case, the analysed variables are stock prices. In all informationally efficient capital markets, asset prices simply reflect all publicly available information sets. New information creates a shock to markets and is instantly observed in asset prices. The thesis observes announcements on interest rate changes as exogenous events and analyses them as a potential shock to stock markets' performance. Event study analysis provides an appropriate estimate in testing for any period lag behaviours and any possible adjustments in trading. Time gaps of market expectations are tested using estimation and event study windows, where by manipulating with these parameters, i.e., by enlarging and reducing them, the estimate integrates time lags between information announcements and decisions in effect. The datasets used in this analysis are based on historical prices, which are obtained from the Bloomberg Terminal real-time data platform.

Time series data analysis retrieves other central banks' decisions and compares current announcements with the main decisions throughout history, taking into consideration the time span from 1998 until 2023. In order to get a more interrelated and realistic financial market analysis, this thesis looks at the intermarket relationships by considering other assets. The analyses of bond markets' performance, commodity and forex markets' movement, and their intercorrelation with stock markets give a more profound state of the overall financial market outlook during the 2022 crisis. Another key research point is a cross-sectional analysis of the high-alert industries and emerging markets' performance, as well as the credibility of undertaken policies and measures. The thesis relies on the S&P 500 and the STOXX Europe 600 indices for stock prices and stock returns. Statistical data analysis, estimations, and inferences are performed in R statistical modelling and computing software.

On the whole, it is important to point out that the main aim of this thesis is to investigate the 2022 crisis from the financial standpoint of view, i.e., from the point of view of interest rate hikes as a consequence policy to the raging inflation in 2022. Moreover, this thesis focuses on the effect of interest rate hikes on other financial system indicators and financial markets, mostly stock markets, by closely empirically analysing the European and the United States stock markets. The goal of the thesis is to empirically investigate stock markets' performance (hence, parallelly for both economies) under monetary policy of increasing key interest rates during the year 2022, whilst comparing the same using previous historical key interest rate decisions when interest rates were either decreased or increased. The thesis, additionally, differentiates among decreasing and increasing key interest rate policies and analyses their specific and individually observed group effect on the stock markets' performance for both economies. Given these points, the thesis observes the ECB's and the FED's decisions on monetary policy implementation as the event dates used as intersection point(s) for further individual and cumulative event study analysis. Analysis and examination of cause and consequence relation is at the core of this thesis. Moreover, it can also be viewed as the analysis and estimation of the monetary policy changes on the stock markets' performance within the EU and the US macroeconomic environment(s). It is based on multivariate

modelling, i.e., the "difference-in-differences" analysis which allows for dynamic lags, where events of interest are estimated across areas (between different asset classes) and time (Clarke & Schythe, 2020). The event study modelling is based on the market model returns.

In conclusion, the thesis focuses on the ten main research questions. The research questions are based on analysing monetary policy decisions during 2022 and their impact on the stock markets' movement, as well as historical monetary decisions and their impact on the stock markets. Namely, in which way, to what degree, and for what reason(s) the stock markets were affected. In order to be more precise, the thesis differentiates among the main research points in the following way: (1) analysis and the impact of the key interest rates' hikes on the stock markets' performance, (2) analysis of the US and the European/Eurozone financial markets and their differences, (3) analysis of the US and the EU monetary policies, (4) analysis of the time-lags between announcements and in-effect decisions, (5) estimation analysis of the lags between market expectations and real-market effect, (6) comparison of the ECB's and FED's announcements and analysis of the credibility issue, (7) comparison of the announcements' effect over-time by identifying other announcements within the time-series constraints, (8) differences among various asset classes and intermarket analysis, (9) analysis of bond market, foreign exchange market and commodities market by looking at the indices that track government bonds, corporate bonds, various commodities and FXs, (10) looking at and separately analysing different industry samples and emerging markets.

1 THEORETICAL FRAMEWORK

Stock markets are one of the most volatile capital markets. Plainly said, it represents a place where shares of publicly listed companies are traded; i.e., a place where demand and supply for these shares meet. Companies using stock markets raise money by publicly selling stakes of ownership to investors, which is for them more efficient way to collect capital than to take on a debt. Investors in return enjoy capital gains that go with the value the company creates and stock becomes more valuable, dividends paid to shareholders as profit grow, voting rights and other benefits extend, all depending on the type of shares bought. Two main stock types are the common and preferred stocks. Common stocks are the most issued stock types, where the share of this stock implicates the ownership in a company and a dividend (a claim) as the portion of profit which is, however, never guaranteed. Preferred stocks, on the other hand, represent a certain level of ownership, they come with a guaranteed dividend, but with no voting rights. Different stock types exist, such as: domestic and international stocks, value and growth stocks, dividend and non-dividend stocks, income stocks, blue chip stocks, etc. This means that stock types develop according to the needs of companies, investor demand, information technology developments, financial innovations, and business progress.

Trading is performed either on the stock exchanges or in the over-the-counter markets. Stock exchanges are more centralized marketplaces, more regulated, all information is publicly

available, as well as all stock prices, less risky and, therefore, more expensive. Whereas, over-the-counter markets are more flexible, less regulated, less expensive, usually performed electronically, and riskier. The overall market liquidity is lower, trading volume is lower, there exists a larger spread between bid price and ask price, and information, as well as the stock prices, are publicly less available than is the case with stock exchanges. The OTCQX, by Forbes in 2023, is the highest quality over-the-counter market for companies that are not listed on regular exchanges. The New York Stock Exchange (NYSE) is the largest one in the world by market capitalization (Statista, 2023). Then follow NASDAQ, Shanghai Stock Exchange (SSE), European New Exchange Technology (Euronext), and many others.

1.1 Importance of stock markets

Although not all researchers agree, one may argue that stock markets power the economy (Ritter, Chopra & Lakonishok, 1992). It comes down to the argumentation between the impact of stock markets on the developed economies and the impact of stock markets on the developing economies and emerging markets. Some researchers think that stock markets represent more of a gamble effect on the positive economic trends in developing markets, whereas a more stable and more consistent factor regarding economic growth in developed markets (Boubakari & Jin, 2010). The reasons for such distinction are found in liquidity creation. Namely, profitable investment creation usually arises from long-term commitment to capital funds raising. This form of commitment is hard to obtain from almost any investor since they do not want to come if they cannot effortlessly leave the market. Investors want to access their invested savings at any time. In order to make both sides level-headed, meaning investors able to reach their savings whenever they want and companies able to sustain long-term capital inflows, generating as high liquidity as possible is found to be a solution. Liquid markets are ones where many participants, both buyers and sellers, interchange constantly; products are standardized and in high demand, entrance and exit are done easily, selling and buying are done at low transaction costs and spreads are relatively small. Most importantly, liquid markets make investments far more attractive and less risky. Investors access their savings at any chosen time. Demand for capital assets is still high enough for companies to ensure their constant regular funding inflows. And as the final result, the risk of investing stays relatively low. However, the argumentation is plausible since the difference between developed and developing markets lies in the number of available participants directly affecting the level of liquidity. More liquid capital markets are observed in developed countries and fewer liquid ones are observed in developing countries (Statista, 2023). At the same time, this very reasoning confirms the vicious loop developing countries may fall into. The better the economic outlook the more business is run, and the more business is run there is more place for even better economic growth. The empirical evidence strongly argues that greater equity (stock) markets liquidity brings upon more boost to economic development enhancing countries' gross domestic product (GDP), employment, wages, and other macroeconomic indicators (Rousseau & Wachtel, 2000).

Another crucial thing, when talking about the importance of stock markets, is the ability of stock markets to predict economic growth and recession. This is, as well, a fairly debated topic among researchers. One could even say, a very controversial issue. As a Nobel laureate, Paul Samuelson once said, "The stock market has predicted nine of the last five recessions.", (IMF, 2011, p. 51). Even though this is not a good enough indicator, traditional theorists still argue that the stock price movements do help in anticipating and in preparing for the worst-case scenarios. They justify their ideas that it has been overall shown that stock price hikes positively correlate with economic growth and stock price drops with economic crisis or recession. Fundamentals are based on the traditional valuation of stock prices which counts for the future anticipation of the economic activity. The future anticipation effect is based on investors' expectations. Investors are realistic observers and predictors of economic and business flows; they form their expectations based on the future predictions which overflow into stock markets and reflect the economic activity as well. Increase in real GDP shows that one economy is going in the right direction and that it shows a strong positive trend in economic performance. The main GDP components are personal consumption, business investments, government spendings and net exports. Investments are fuels to economic growth. The goal of each productive government is to increase investment rates, thereby boosting production, enhancing business environment, and increasing rates of employment. Stock markets are the core platform for public to invest. When considering the level of companies, it is far more efficient to collect the capital from prominent investors and their saving rather than taking on the debt. For the most companies it is easier to give up the part of the ownership in exchange for equity funding, since no repayment of the debt or interest is required. Debt fundings are usually preferred by smaller businesses. Overall, the stock markets do exhibit many advantages on micro and macro levels. They may not be the perfect indicators of economic crisis and recession, but they do tend to forecast many probable economic deviations. The equity funding for corporations is another main primacy of the stock markets. It leaves the companies more options and it takes the burden off them to engage in debt fundings and risk of interest rate volatility. Such alleviation brings upon new points of view reflecting, as a consequence, a surge of innovations and further financial and economic developments. The stock markets are defined to be forward-looking. The price of stock an investor is willing to buy reflects its expectations and reflects its predictions on how well the company will perform in the future. The stock price valuation theory is, yet, another core evidence of the stock markets' importance. This theory is backed up empirically by the analysis of the economic and the stock markets cycle, where the economic cycle post-follows the stock markets one and both are positively correlated. In such case the stock markets start to recover while the economy is still in recession and information sets negative, the economic cycle follows with a justified lag since many investors are sensitive to negative information.

1.1.1 European vs. US stock markets

The European market is a wide term. It can refer to all countries geographically located on the soil of the European continent, it can refer to countries merged into the European Union,

as well as to the countries forming the eurozone market whose common currency is Euro. In order to be as precise as possible, I will always emphasize which exact market I am talking about. Nonetheless, all three versions are very much interrelated. It is just the matter of the scope one wants to talk about, either market as the whole or its subsets. It is impossible that any change in the smallest subset does not reflect the other one or the market as the whole.

The European area consists of many stock exchanges. Each country has at least one stock exchange. The best performing stock exchanges are: Euronext, London Stock Exchange, SIX Swiss Exchange, Deutsche Börse, Nasdaq Nordic and Baltic Exchanges and BME Spanish Exchanges. Exactly in this respective order, these six European stock exchanges represent the largest ones, as of October 2022, by the domestic market capitalization. The biggest stock exchange, the Euronext, constitutes of five markets based in Amsterdam, Brussels, Dublin, Lisbon, London, Oslo and Paris. The market capital of the Euronext, as of October 2022 amounts to 5.5 trillion US dollars. Globally, the Euronext is the fourth largest stock exchange. The market capitalization of other stock exchanges, as of October 2022, is as follows: London Stock Exchange (2.8 trillion US dollars), SIX Swiss Exchange (1.7 trillion US dollars), Deutsche Börse (1.69 trillion US dollars), Nasdaq Nordic and Baltic Exchanges (1.67 trillion US dollars) and BME Spanish Exchanges (608.8 billion US dollars), (Statista, 2023). The Euronext is the pan-European stock exchange, it trades regulated stocks (equities), bonds, derivatives, warrants and certificates, commodities, exchange-traded funds (ETF), indices and currencies. On the list of the top ten global stock exchanges, next to the Euronext which takes the fourth place, is the London Stock Exchange. It hits the high eight place valued by market capitalization. Therefore, two European stock exchanges are included into the top ten biggest exchanges in the world.

The largest stock exchange in the world is the New York Stock Exchange (NYSE). Its market capitalization amounts to 23 trillion US dollars. The two United States stock exchanges are the top two largest exchanges in the world. Next to the NYSE is NASDAQ, which reached the market capital of 16.9 trillion US dollars. The data are as of October 2022, as well (Statista, 2023). The NASDAQ stock exchange is specific one at its core. It is unique due to the focus on the high-tech companies exclusively, where over 3,500 firms are publicly listed on this exchange. Another specificity is that this exchange has the greatest trading volume than any other stock exchange in the US with approximately 1.8 billion trades per day. There exist smaller stock exchanges in the United States as well, based in different regions, cities or states. However, their scope and impact are incomparable with the NYSE and NASDAQ. All stock exchanges are regulated and in order for the company to be listed on the stock exchange it must fulfil prescribed minimum requirements. Through the history, mergers and acquisitions among stock exchanges were present, but mostly within a very narrow location scope where a larger exchange acquires smaller one. Over the decades, stock exchanges started to completely change their model of business. Historically, they used to be very institutionalized and nationalized. However, as globalization grew, the stock markets started to change the way business is run. Over the decades, a lot of mergers and acquisitions took

place; not only on a national level, but across regions, unions, even continents. The opportunity of globalization process was used to make business model more flexible enlarging the profit-maximization options. The Euronext is one such recent example and NASDAQ acquiring the Nordic stock market OMX in 2007 is a transatlantic example. In order to get a proper understanding of the 2022 crisis and its implication on the stock price movement, it is of a huge importance to analyse the European and the US industries which form the main stock indices of these two markets. Stock indices, such as S&P 500 or STOXX Europe 600, are the main indicators and measures of the stock market. They help investors to get a clear picture of the stock markets' performance, to compare the current stock prices with historical ones, to compare them and to make reasonable investment decisions under their own preferences and expectations. To have a clearer picture, I want to emphasize that the US is the leading country in the world by the GDP estimator, whose value for the 2021 reached 23.32 trillion US dollars. The first EU country on the list is Germany with 4.26 trillion US dollars, then France reaching the value of 2.96 trillion US dollars, Italy 2.11 trillion US dollars and Spain 1.43 trillion US dollars. United Kingdom, which is not part of the EU anymore, is just after Germany with the estimated gross domestic product of 3.13 trillion US dollars for the year 2021 (World Bank, 2022).

The 2008 crisis left enormous consequences on the US economy. It hit other economies too, but not as much as it did the United States. When the stock markets crashed, it was expected that European countries will be the first to recover and outgrow the US stock markets by a large margin. It did begin this way. The European markets started the recovery first, where it was expected that the US stock markets will have prolonged crisis effects. No constraints were seen to object to further European stock indices increase. At the point when European stocks fairly outperformed the US ones and the US indices started to slowly recover, the EU and the eurozone were hit by their own crisis, the debt crisis. The European sovereign debt crisis started in 2009 due to extremely high government debts and institutional failures of some EU member states. Observing the data of stock market performance among the Europe and the US from 2008 until 2020, the US stock index trend performed unexpectedly positive. While everyone expected the US markets to follow-up the European stock markets' growth, due to Europe's own crisis they outperformed their stock index growth by a double margin until the year 2019. Meaning that investment in S&P 500 in 2008 would worth double by the end of 2019, compared to an investment in STOXX Europe 600. It took more than a decade of continuous policies, economic strengthening, negative interest rates and many other measures for the eurozone and the EU to stabilize the financial markets.

Although both the EU and the US are among the world's most developed economies, where the US is the top leader, their industries are differently constituted. When compared one can say that their industries are very asymmetrical. Due to this asymmetry one identical crisis can have widely different effects on each of these economies and their financial markets. In this regard, S&P 500 and STOXX Europe 600 as the main stock indices for each of the two stock markets are now compared. While both constitute of the same industry categories, their

weights are completely different. Bloomberg data (2023) show that the S&P 500 holds the highest weight in the IT sector, approximated to be 20% larger than in Europe 600 index. The communication sector comes next in line, which is by around 4% estimated to be larger than in the latter. Real estate sector and consumer discretionary sector (luxury/non-essential goods and services for entertainment and leisure) follow by slightly larger percentage. Therefore, the market capitalization of the US mostly, yet not exclusively, evolves around the IT sector. The European stock index industry weights and market capitalization are mostly based on production and manufacturing sector, material sector and consumer staples (essential consumer goods) industry. Each approximates to 6% larger intake within the stock index industry weighting compared to S&P 500. On the top, all three sectors represent a very energy-intensive industries. While the United States are among the three largest oil and gas producers, the EU's dependence on Russian energy supplies has deepened the 2022 crisis.

1.1.2 Emerging markets stock performance

Emerging markets is the term defining the economies undergoing fast economic growth rate. These economies transit from less developed, low income to modern, industrial economies with higher living standards. Refinitiv data (2023) lists the top five major emerging markets, namely China, Brazil, India, Russia and South Africa. The current political and war situation does challenge Russia's path towards further economic development in the near future, considering the worldwide imposed sanctions, especially from the United States and the European Union. On the other hand, China has observed the economic growth decline, due to the COVID-19 crisis and its zero-Covid policy. The current raging inflation will be a decisive factor in how emerging markets will continue to develop. The Refinitiv data show that better-performing emerging markets for the year 2022 are led by Latin America, namely Brazil, Chile and Peru. Asian region showed the poor performance, especially China, Taiwan and South Korea. Mainly, the reason is due to post-Covid recovery, but also political and military tensions between China and Taiwan. The Eastern Europe performed the worst, due to imposed sanctions on the Russian Federation, but also due to bad economic performance of Hungary and Poland. However, the last quarter of the 2022 showed China's better performance and decisiveness in focusing again on the economic growth and reopening. It performed better in the sectors of health care, communication services and real estate.

The emerging markets are indexed, so analysts can easily follow their rates of growth, their improvements and retrogressions. Different indices exist and different key classifications; however, the most widely used one is the MSCI Emerging Markets Index. It stands for the Morgan Stanley Capital International. This index represents a set of stocks created from the key companies within the emerging markets scope in order to trace their financial capacity and performance. Other indices come from IMF, S&P, Dow Jones and Russell Index. It is very important to underline that investors can always take the advantage of these indices when trading, since many mutual funds and ETFs use it as their benchmark rate. The MSCI

index includes 24 emerging market[1] countries and 1,374 companies. MSCI Inc. data on MSCI Emerging Markets Index annual performance as a percentage of cumulative index performance net returns observed the highest drop in 2022 over the period of the last decade, amounting to -20.09%. In order to have a clearer picture, the MSCI All Country World Index annual performance as a percentage of net returns amounted to -18.36%. The previous drop of the MSCI Emerging Market Index annual performance (% of net returns) was observed in 2018 amounting to -14.57%, whereas the MSCI ACWI annual performance (% of net returns) for the same year amounted to -9.41%. On the contrary, the highest level of the same indicator for the MSCI Emerging Markets Index was observed in the year 2009 amounting to 78.51%, following with the year 2017 of 37.28%. The same indicator for the same index in the year 2019 amounted to 18.42%, in the year 2020 it amounted to 18.31%, in the year 2021 it fell to -2.54%. After the COVID-19 drop, the MSCI EM Index started to recover and increase sharply all until mid-2021. It then, started to decrease until the last (Q4) quarter of 2022, when we can observe slow recovery of the emerging markets. Definitely, the largest weight among countries within the MSCI index has China (33.49%). Taiwan follows with the weight of 14.42%, then India (12.97%), South Korea (11.81%), Brazil (5.2%) and others. The largest sector weight holds the financial sector (21.21%), followed by IT sector (19.62%). Consumer discretionary sectors takes the third place with 14.54% weight. The last data are stated for the year 2022 (MSCI Inc./MSCI Emerging Market Index Data, 2023).

1.2 Stock markets and inflation

Inflation, as a rate of increase in prices over a defined time period, is an exceptionally volatile parameter. Due to its volatility feature, the uncertainty it brings to financial markets causes serious headaches to the market participants, as well as to the governments. Stock markets are highly sensitive to inflation rate changes. However, there are differences as to how the inflation changes affect stock markets in the short-term period and in the long-term period. In order to reach a complete overview of correlation between stock prices and inflation rates, I look into both time determinants. Nonetheless, the relation between stock prices and rates of inflation is not straight-forward and is usually very complex. Yet, analysts argue that in overall terms, short-term inflation effect is much more ravaging on the stock price movement than the long-term one. Difference among stock markets and inflation also depends on the stock type, not all stocks react the same when the high inflationary environment emerges.

The stocks market is said to be the central institution of capitalism (Mueller, 2018). As the stock markets develop, so does the capitalism evolve. The core and the central interest of all market participants is to increase their initial capital. Companies want their business to grow and investors want to earn additional money. Basically, each side is eager to increase their capital portfolio and each takes the advantage of the other. However, the theory of the value

[1] The MSCI index emerging market countries are: Brazil, Chile, China, Colombia, Czech Republic, Egypt, Greece, Hungary, India, Indonesia, Korea, Kuwait, Malaysia, Mexico, Peru, Philippines, Poland, Qatar, Saudi Arabia, South Africa, Taiwan, Thailand, Turkey and United Arab Emirates.

of money puts additional complexity into the investment process. From the times of barter trade, all until this time and age, the money has changed many of its forms. But the three main functions of money have always remained. Those are: unit of account, store of value and medium of exchange. We usually think of money only in terms of currency and cash as an asset that holds the real money value. The truth is that the store of value is found in assets like currency, commodity, gold, equity or any other asset form that can retain its purchasing power in the future. Hence, the value of the money or an asset is represented in its purchasing power. Inflation, on the other hand, acts as the main threat to the value of money. Due to its high volatility deviations, it acts negatively on the purchasing power making the value of money erode over time. The purchasing power of money is completely depending on the price levels. The rate at which prices increase is the rate at which the unit of money value decreases. The same is applicable to equities, as it is to currencies or other financial assets. All investors have the goal of obtaining positive real returns on their investments. If the investor earns 3% return on the portfolio in one year and inflation rate is 2%, its real return is 1%. However, if the inflation rate is 5%, his real return is negative, -2%. It is not about the nominal rates, but rather the real return rates. Although, it is widely agreed that a low and stable level of inflation within the economy does help reach the positive economic outlook in the mid- to long-term, high inflation rates, however, devour the value of money and destabilise the markets. The loss of real income is the ultimate consequence.

As mentioned, the short-term effect of inflation increase is more severe on the stock prices than it is the long-term effect. The short-term effect is viewed as the immediate shock to the stock market. The correlation among stock prices movement and inflation is negative, stock prices fall when the inflation rate increases. Various reasons stand behind this relation. One is found in the monetary policy adjustment decisions with an aim of stabilizing the economy and decreasing inflation rate. As is the case in this research thesis, monetary policy creators reach for measures of increasing the key interest rates, slowly in consecutive short-terms. The goal is to slow the economic performance, lower consumption, lower spendings, and ultimately push the prices down. Investors, in such cases, tend to substitute stocks from their portfolio with more secure investments, such are the lower priced bonds. Reasoning behind this substitution is that bonds are less risky than stocks. Bond markets react, but differently. This pushes the stock prices down. Then, as the purchasing power is decreased by inflation rate increase, companies' short-term revenues, as well as profits, tend to decrease causing immediate negative shock to stock prices. Reduced economic performance, overall lower demand for stocks as a consequence of lowered spendings and negative real returns obtained on stocks portfolio, increased interest rates on debt which fuel companies' costs and further, additionally, burden companies' net income statement, together with other negative micro- and macroeconomic determinants push the stock prices temporarily down. The issue with the long-term effect relies on the possible recovery of the store value of the stock as the time lapses. In this case the store value of an asset has a high probability of value appreciation over long period and the stock price retains the real wealth value. However, it is mostly the case that investors do not have patience to wait since the flexibility of exiting the market on

their own wish is very important to them. Hence, the higher significance of short-term effect. The long-term adjustment of the store value of the stocks is one of the ways to hedge against inflation increase. Still, it is not only the time span that is important, but also the stock type.

Different stock types are better than the others in the periods of high inflation. For example, it is the case with value stocks. Value stocks outperform growth stocks in such environment. The reason mostly argued by researchers is based exactly on the advantages of the long-run period, as discussed. Namely, the value stocks are stocks of highly established corporations with substantial cash reserves. Based on these cash reserves, these companies are able to fill the leaks that inflation creates. Investors believe that companies will perform their best and sustain the firm's value throughout the crisis, whereas they neither leave nor sell their shares. Investors base their expectations on this belief and by doing so hedge against market risk in the long-run. On the other side, growth stocks are stocks of the companies showing the trend of positive and perspective growth. Such companies do not have enough of the current free cash flows. They might even not be able to regularly pay out the dividends. Prices of such stocks tend to be highly sensitive to inflationary deviations and, almost as a rule, stock price goes down when inflation rate increases. Long-term hedging, in this case, has the small level of probability to work out successfully, since it is highly unpredictable to forecast whether the company will survive the intensity of the crisis or what the intensity of the crisis will be. International stocks are usually sensitive to inflation changes, due to numerous interrelated risks, especially the foreign exchange risk, different monetary tightening measures and the adjustment within the new environment of the market competitive advantage exploitation. Income stocks are, as well, usually reactive to inflation increase. These stocks refer to the companies which pay out regular dividends. The prices of these stocks also tend to fall when inflation hits, since the purchasing power decreases and the store value of dividends losses its real worth. Over the long-time, depending on the stability of the company, the stock prices of such companies can again increase if the dividends (income) increase.

It is also very important to differentiate between different inflation types. There are two main types of inflation, the cost-push inflation and demand-pull inflation. The 2022 crisis inflation is an example of a cost-push inflation, whereas the COVID-19 crisis inflation can be defined as a demand-pull inflation. Due to the exogenous factors and specificity of a war conditions, the scarce of recourses affects the supply for such goods. This could and still is continued to be seen in food product prices whose production relies on agricultural products and industry of the war-affected area. It is also observed in oil and gas scarcity. Decreased supply of such necessities increased the overall price level across the European countries. An opposite was seen during the COVID-19 crisis. The necessities, such are the protective masks, disinfectant solutions, gloves and vitamins did not observe the supply decrease. The supply continued as it did regularly, however the demand substantially increased and pushed the prices upwards.

1.3 Volatility and stock markets historical movement

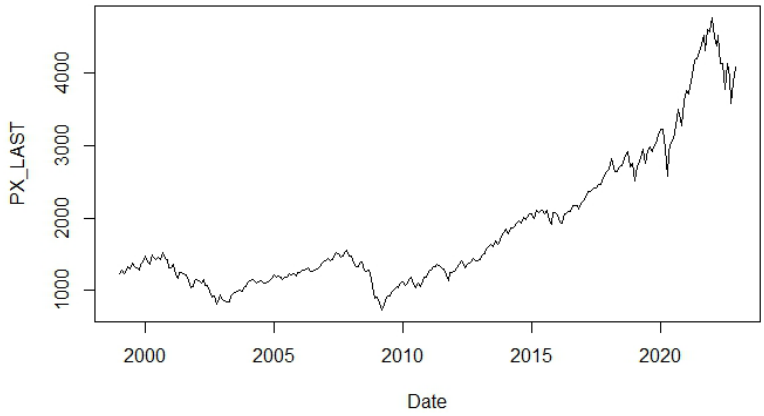
Volatility is the statistical measure of dispersion. It measures the rate at which the variable (for example, the return on stock price) changes over the period of time. As mentioned, the stock price returns are very volatile, i.e., their rates of change are unpredictable and quick. At this notion, the stock markets are one of the most volatile financial markets, right after the foreign exchange markets. Volatility implies a high rate of risk. The standard deviation of an annualised stock returns over a long period helps investors adopt their expectations in an attempt to create a less risky portfolios. The stock prices and their annualised returns are in a high degree affected by many different events. Those events can be company internal or company external factors, industry factors as a form of microeconomic changes, all to large spectrum of macroeconomic and global events. For example, just one political speech can lead to increased stock market volatility, and push the prices instantly up or down. Financial reporting, industry changes, increased market competitiveness, management changes, CEO resignation, elections, government changes, strikes, wage reductions, low or high levels of unemployment, companies' revenues and profit increase, global pandemics, war conflicts, and many other examples, of the smallest to the largest degree, affect stock market volatility. The challenge of the stock market volatility is a feature that drives many risk-taking investors to challenge their luck and take the advantage of the price changes in their own behalf. This is a very interesting concept of behavioural financial science. The adrenaline rush and huge levels of uncertainty are predominant reasons for some investors to hold on to stock markets.

Even though the stock indices, usually, tend to follow the similar pattern of movement, due to global intercorrelation, one does perform better than the others. While the S&P 500 index in 2022 observed the highest volatility since the 2008 crisis, the Refinitiv (2023) data show that the FTSE 100 performed better than all other stock indices. Analysts argue that the FTSE 100 holds one of the most stable companies worldwide (IG, 2023). However, the strength of oil corporations like BP and Shell was the main reason for the FTSE 100 outperformance of other stock indices. Current war conflict was a main driving force in raising stock prices of these two companies. Only the BP announced that their profits doubled in 2022. Other blue-chip companies additionally have supported overall index performance and maintained the UK's hope of lessened crisis impact on financial stability. The European STOXX 50 and STOXX 600 indices performed poorly. The main reason is the less stable portfolio of firms within the industries hit by geopolitical situation, mainly within the energy sector. The conflict still remains and future stock price movements will highly depend on the resolution of the same, and on substitute policies for scarce resources.

The S&P 500 stock index covers roughly 50% of the global equity market capitalization (Bloomberg data, 2023). Namely, throughout the history until now, it shows the positive increasing trend. Major disruptions to the market happened at times of big crises. The most recent history shows major market fall from March 2000 until the beginning of 2003 due to the NASDAQ market crash and the so-called dot-com recession crisis. The biggest hit to the

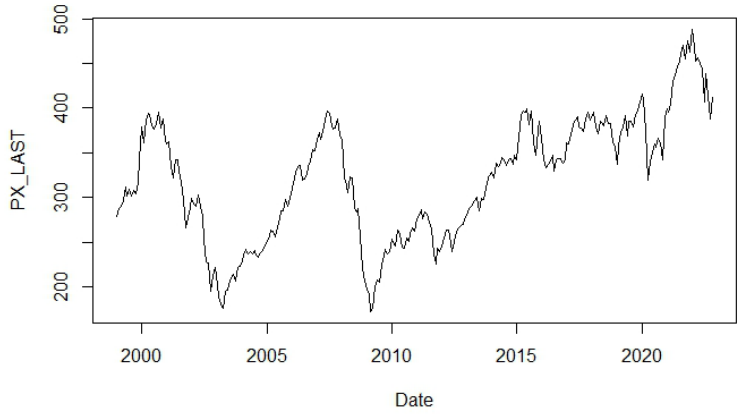
market was the 2008 crisis, so-called The Great Recession crisis, lasting from 2007 until the end of 2009. It caused the biggest shock to the stock market. The stock prices rambled down with a high-speed rate. Then the COVID-19 crisis follows, causing S&P 500 index rate to decrease in the first half of 2020. In the second half of 2020 the index rate started to recover, declining again at the beginning of 2022. The Europe STOXX 600 stock index marks the same major crises and index rate declines. Both indices observe the best performance at the end of 2021. Between the beginning and the end of 2022, slight improvements are observed in the last quarter, (Q4); however, both indices still forcefully struggle to reach the stability. The following two graphs, presented by Figure 1 and Figure 2, show S&P 500 and Europe STOXX 600 historical movement of price rates. The data are sourced from the Bloomberg Terminal real-time database system and the graphs are created using the R software.

Figure 1: Historical price movement, S&P 500 Index



Source: Own work.
Note: Period of prices is on monthly level, currency is USD.

Figure 2: Historical price movement, Europe STOXX 600 Index



Source: Own work.
Note: Period of prices is on monthly level, currency is EUR.

1.4 Correlation of other markets with stock prices

Different markets react differently to external shocks. Each market carries its own bundle of risks, hence the difference in market reactions. Nonetheless, all markets do react to inflation shocks. The main differences are in how sensitive they are to inflation shocks and how much time it takes until the specific market starts reacting. Choosing between different financial assets and different financial markets gives investors more options and helps diversify their portfolio risk. Talking about stock markets makes it hard not to talk about bond market, then foreign exchange market and commodity market. Such analysis is defined as the intermarket analysis. These four markets represent the main and the core financial markets.

1.4.1 Bond markets and different bond classes

Empirical analyses show that bond returns tend to positively correlate with stock returns in the long-run period. However, there is substantial time variation in the relation between stock and bond returns over the short period including sustained periods of negative correlation (Connolly, Stivers, Sun, 2005). Simply put, bonds are fixed-income investments where no equity is involved. When investing in bonds investors borrow either to a company or to the government. A bond is a debt security where investor accepts to receive a fixed income interest over the invested time period, and a whole investment repayment after bond maturity expires in exchange to borrow the money to the second party. Bond types are various[2]. Yet, the main reason why any of bond types are preferred compared to other financial assets is because they provide the fixed stream of income. Bonds are highly preferred by risk-averse investors. Bonds are secondary market securities, mostly traded on the OTC markets, while smaller portion is traded publicly over the large exchanges. The reason is mostly found in their diverse features; each bond holds different maturity rates, yields and qualities.

When inflation rises it pushes the interest rates upwards. High interest rates are inversely related to bond prices. Yield to maturity represents a percentage rate of return, i.e., an internal rate of return for the bond if it is held to maturity. The yield, on the other hand, is an annual profit earned on bond investment. Yield to maturity is very sensitive to interest rate increase. Even though both stock returns and bond returns react inversely to inflation hikes, there are different response lags. It is very hard to explain why the short-run correlation among the bonds and the stocks varies, due to multiple factors involved. However, many researchers look into this problem from the points of division between recession and expansion periods. For example, Boyd, Hu, Jagannathan (2005) and Andersen, Bollerslev, Diebold, Vega, (2007) research papers argue that more positive correlation among stock and bond returns is during the expansion periods, due to the discount rate effect; whereas, more variations and more frequent negative correlations occur during the time of contractions, mostly as a

[2] The main division of bonds includes: fixed-rate bonds, floating-rate bonds, zero-coupon bonds, perpetual bonds, convertible bonds, inflation-linked bonds, callable bonds and puttable bonds. Out of this division arise: government bonds, municipal bonds, corporate bonds, high yield bonds, investment grade bonds, etc.

consequence of the cash flow effect. Research, such is from Jensen and Mercer (2003), showed the contrary argumentation evidence for the across time difference. Namely, they argued that expansion periods bring lower stocks-bonds correlation and contraction periods bring higher correlation among the two. Yet, Yang, Zhou, Wang (2009) explain this completely opposite hypothesis to be more relevant for the small cap stocks than for the large cap stocks, due to the large difference among statistical significance between the two stock categories and cannot be generalized to all stocks. Overall, it is very important to highlight that bond prices were highly affected in 2022. Many analysts argue that the bond markets outlook, after the years of negative yields, will be brighter in 2023.

1.4.2 Foreign exchange markets and FX rates

The foreign exchange markets, often called the forex markets, exhibit higher volatility than the stock markets. The two markets tend to move in correlation with one another. If the stock market prices increase, they attract more foreign capital inflows and increase the demand for the domestic currency. The opposite is valid if the stock prices go down. Both markets are very sensitive to inflation rate increase. As already discussed, as inflation goes up the real money worth is reduced and demand for that country's currency is decreased. The literature, moreover, provides evidence that the correlation between stock returns volatility and foreign exchange rates volatility highly depends on the level of economic development rather than the time variant. Walid, Chaker, Masood, Fry (2011) argue that the volatility between the two is higher in emerging countries at the times of serious economic contractions than it is in developed countries during the periods of crises. The three main classifications of forex market are: the futures, the forward and the spot foreign exchange markets. The spot market represents the place where the exchange in currencies is done at the moment, on the spot. The other two, the forward and futures forex markets involve the agreement between the parties. The forward market agreement means that parties agree on the exchange rate price, which is performed in the future at the date they agree upon in the agreement. The trade between currencies settles when the agreement expiration date comes, in the over-the-counter form. Futures forex market is very similar with the difference that here the currencies are traded on the exchange, the contract is more standardized, and prices are settled on the regular (usually daily) basis until the end of the agreement. Both of these two forex markets are mainly used to hedge against the market volatility, mostly the forwards. Exchange rates, on the other hand, are prices for which one currency is exchanged for the other one. The Bloomberg historical data on EUR-USD exchange rate shows that the price of the currency pair exhibited the falling trend from the mid-2021 until the mid-2022. The lowest price was observed in the third and the beginning of the fourth quarter of 2022. The lowest price level was deviating from 0.97 to 0.99 USD. The reason is that in this period Russia stopped supplying the eurozone with oil and gas resources, and the value of the Euro currency was highly impacted. The price of the currency pair is exhibiting increasing trend from the beginning of November 2022 with an indication that increase will continue in the year 2023.

1.4.3 Commodity markets

The primary products or raw materials are the subject of trade in the commodity markets. It is usually the case that commodities in this market are divided into hard and soft ones. Hard commodities are natural resources, whereas soft commodities are agricultural resources. The most traded commodities globally are: crude oil, natural gas, gold, uranium, copper, silver, coffee, sugar, cotton and cocoa (Bloomberg, 2023). Many other commodities are traded, but in a slightly lower degree. Historical prices of commodity markets do show high volatility deviations. The link between stock and commodity prices exists, but the literature mostly provides empirical analyses based on the oil prices and the stock returns volatility. For example, Creti, Joets, Mignon (2013) research paper empirically shows that the correlation between stock returns and commodity returns evolves over time. The basepoint was the 2008 crisis. The short-run effect exhibited the less positive correlation among the two markets; however, the correlation increased as the crisis worsened. The study confirms the significant degree of interrelation among these two markets and suggests that one does not substitute one of these assets with the other in their portfolio(s). The risk level both assets hold is quite similar and would not add towards the diversification effect. The study points out oil, cocoa, and coffee. The correlation increase is, though, observed in times of stock price increase and diminishes in times of bearish markets.

2 MONETARY POLICIES AND DECISIONS

The key macroeconomic policy, next to the fiscal policy and the exchange rate policy, is the monetary policy. The monetary policy has the main goal of keeping stability of the price levels within the economy and preserving the value of domestic currency. The policy reaches goals by controlling the money supply, therefore directly affecting the economic growth. The central bank is the institution which manages this policy. In order to properly act and adjust the monetary policy in accordance with economic and financial movements, the Federal Open Market Committee, as the main decision body within the Federal Reserve System, meets eight times a year to rethink and bring changes to the monetary policy of the United States. On the other hand, the European Central Bank's main decision-making body is the Governing Council. The Council meets every two weeks and every six weeks it brings new decisions on the eurozone monetary policy. Meetings of both bodies take place on more regular basis at the times of crises, such is the case in 2022, and as it is planned for 2023. Monetary policies of developed economies, as are the United States and the eurozone, not only affect these respective economies but have a much more widespread effect. These monetary policies affect all those developing, transitionary countries, and emerging markets whose domestic values and exchange rate systems are pegged to the US dollar or the euro.

The monetary policy depends on the exchange rate arrangements the country relies upon. It is usually differentiated between the flexible exchange rate arrangement, which is also called

the targeting model, and the fixed exchange rate arrangements, often defined as the exchange rate rule. The flexible exchange rate system is based on targeting the specific monetary aggregate and the rate of its intermedium deviation. Such flexible system is the one upon which both the FED and the ECB operate. Both monetary institutions target the stable level of the inflation rate by their monetary aggregates, setting its intermediate rate to be around 2%. The flexibility form pertains to developed economies. On the contrary, the fixed rate arrangement leaves a very poor space for domestic central banks to react on both, the internal and external, shocks. The gaps in which exchange rates, within this system, move depend on how strict the fixed arrangement is. For example, one very interesting case of the extreme version of fixed exchange rate agreement is Bosnia and Herzegovina. High political distrust, institutional complexity, national conflicts, and other factors all led to establishment of the currency board model. Such model is based on the very strict rules, where monetary policy is extremely passive and does not have any discretionary rights as a typical central bank. The domestic currency is firmly fixed to the euro currency, at the rate where 1 BAM = 0.51 EUR.

From the dissolvement of the Bretton-Woods agreement in the 1970s, exchange rate systems of many developing countries changed to a more quasi-flexible exchange rate arrangement. They were not completely targeting models, yet not completely fixed, i.e., neither currency board nor full-pledged dollar systems. Increase in the world capital markets integration and increase in the capital flows volatility, especially after the 1992 European Monetary System crisis, exhibited the hardship of quasi-fixed exchange rate arrangement preservation. Even though such arrangements did help many industrial countries with high inflation crises, like Argentina in 1991 or Brazil during 1994-1998, more and more such countries are at the brick of reforming these arrangements, in respect to new capital flow challenges. It is argued that either extreme forms of fixed exchange rate systems or extreme flexible arrangements are a better way to confront ever-increasing globalisation challenges of the capital markets and capital inflows (Croce & Khan, 2000). The credibility of the monetary policy is important factor central banks have to take care of. Regular updates on monetary policy performance and new decisions give rise to public confidence, reduce panic and leverage overall stability.

2.1 On objectives and instruments

Objectives of the monetary policy are the goals which monetary policy creators wish to aim for. Those are, predominantly, the price stability and stability of the currency value. As said, the main goals of the ECB and the FED is to keep the intermedium inflation rate at the 2%. They do so by using monetary aggregates. This means that they influence the inflation rate over the key interest rate changes. The key interest rate changes, increases or decreases, have the ultimate effect on the changes of the inflation rate movement patterns. This small level of inflation, the 2% rate, is an estimate which is needed as the fuel to keep the economic growth rate stable with an increasing trend and to be just enough above the deflationary environment, which may exhibit more harmful effects on the economic development than

the inflation boosted environment. Theoretically, the key monetary policy tools at the hand of central bankers are the open market operations, the discount rate and the reserve requirements. Central banks use the open market operations in order to trade with securities in the open markets with the goal of sustaining liquidity of the reserve balances and creating a fundament for further key interest rate manipulation. The FOMC, for example, uses the open market operations to keep the federal funds rate at the level which will ensure targeted price average. The federal funds overnight rate is the rate used by depository institutions to lend reserve balances to other depository institutions overnight. Federal funds rate is the main interest rate of the FED to keep the economy at the stable path. Reserve requirements rate is the minimum prescribed rate of reserves which all depository institutions have to hold against their liabilities. Last, but not the least, is the discount rate. It is the rate at which commercial banks and other depository institutions can take the loan from the central bank. Using these three tools, central banks influence demand and supply of balances among the depository institutions and balances these institutions have as reserves in the central banks. Tools, ultimately, keep monetary system safely operating and steer the key interest rates.

2.1.1 Differences and similarities among ECB and FED

It is definitely the fact that both have more similarities than differences. The main similarity is that they both operate through open market operations, hence maintaining liquidity reserve supply in this way. The Federal Reserve System is very specific compared to other national banks, due to its semi-decentralized form. The FED consists of the Board of Governors and twelve regional Federal Reserve banks. Each of these banks is responsible for supporting and overseeing commercial banks and other depository institutions of the region. However, the FED is run by the Board of Governors at the national level and all regional FED banks are under their supervision. The European Central Bank is fairly similar, yet again different to Federal Reserve System. Its specificity stems from the whole idea of the European Union. The EU represents a unique economic and political union between 27 European countries (European Commission, 2022). Yet, all these countries preserve their sovereignty. The ECB, as the main body, includes in its network all central banks from all those countries that accepted the euro as their common currency, i.e., the eurozone countries. The euro currency decision-making processes are very centralized; however, countries' individual central bank network is decentralized and helps in monetary policy implementation and support on more individual national levels. Furthermore, both ECB and FED target the same level of inflation rate, the 2% intermedium target level. They are the two most powerful central banks. They both manage and oversee one of the world's most powerful economies. When talking about differences, it is firstly important to say that the FED has a far longer history of operation, since it was established on the December 23rd, 1913, whereas the ECB was established on the June 1st, 1998. Each is the home to two different currencies, the US dollar and the euro. However, the most important difference is in policy objectives. While the ECB sets the main goal to be the price stability, and both set the same inflation rate target, the US Congress imposes two main goals for the FED, where the primary goal is the maximum employment

and, afterwards, the price stability. Other differences are minor and operate on the same run mechanism. Example are the main operating interest rates. While FED focuses on the federal funds rate, the ECB focuses on the main refinancing operations rate, the deposit facility rate and the marginal lending facility rate. The main refinancing operations rate (MRO) is the main short-term operations rate, which provides the eurozone banking system with liquidity. The marginal lending facility rate is an overnight rate providing depository institutions with overnight credits from the Eurosystem. Depository institutions use the deposit facility rate to make overnight deposits with the Eurosystem. It is oftentimes interchangeably in literature used "policy rate" as a synonym expression for the key interest rates. The main refinancing operations rate is an adequate short-term rate equivalent to the FED's federal funds rate.

As it can be observed in the current 2022 crisis, the Federal Reserve System does on average change its policy rate more often than it is the case with the European Central Bank's policy rates. Over the period from January 1999 to January 2006, the ECB has changed its main refinancing rate 16 times, whereas the FED has changed its target for the federal funds rate about twice as often (Sahuc & Smets, 2006). Even higher difference is observed after the 2008 crisis. From 2008 crisis, the FED started to define the federal funds rate in interval base setting the minimum and maximum variation limits in which it is wishful that the rate moves. The more often changes of FED's policy rate started to be the core argumentation to ECB's critics, asking for a more intensive and more active involvement of the ECB's inclusion in the monetary processes. However, many agree on the adequate response to the 2022 crisis.

2.1.2 Deeper look into key interest rates

Key interest rates of both FED and ECB have changed numerous times, whenever the need was raised during the times of crises. The FED has changed its federal funds rate more than the ECB did, historical data show. As the Federal Reserve System operates far longer than the European Central Bank does, the transparency of data of the same has changed over time. Before 1994 the data were much less transparent, conferences were not held and the Bank did not publicly publish the policy statements. The FED statistics, (FRED, 2023), shows that 1990s were not an easy time for the economy, due to the Gulf War recession. From the mid-1990 until the mid-1992 the FED had cut its policy rate even eighteen times to get an economy going again. It was decreased from 8% to 3% over the two-year time span. Further set of changes happened in the period of 1994-1995. The economy was transforming due to advances in information technologies, strong immigration and low unemployment set a fundament for rate changes. The monetary policy creators decided to back-up the economic growth pattern by increasing the rate from 3.25% to 6% in seven consecutive times over the period of one year. The year 1995 and 1996 were years of mid-adjustments due to pressured inflation with previous monetary tightening measures. The rate was decreased to 5.25% in seven-months period and in three consecutive meetings. Then, followed an increase of federal funds rate to 5.5% in March 1997. The rate was increased because the inflation was 1.94% in March 1997. It showed no increase anticipation and the FED wanted to ensure that

it reaches the 2% target level. The year 1998 was the year of global currency crisis. The crisis drove FED to take the action against potential market disruption and decreased the rate from 5.25% to 4.75% on three occasions within the two-month period. The dot-com crisis was boiling in the 2000, driving FED to increase the rate six times in one year time, from 5% to 6%. When it boomed, eleven consecutive rate decreases followed. But this is not everything. The FED decreased rate in one-year time period from 6% to 1.75%. In 2002 and 2003, two new cuts took place, as an adjustment to record low inflation level of 1.47% in mid of 2003.

Worried about deflation, the FED decreased rate to 1%. The housing market boom was next on the track, where the rate was increased seventeen times prior from 2004-2006, increased to 5.25%. Cuts took place when the crisis boomed, seven times in a one-year time period. The minimum rate was 2%. When stock markets collapsed, rate was further decreased to the low of 0%-0.25% range level. This was the December 16th, 2008. Period of 2007-2008 marks the period of the Great recession. The years 2015-2018 was a normalization period, increase of the federal funds rate followed. The rate in this period was increased nine times, the largest range was 2.25%-2.5%. The rate range level was decreased to minimum of 1.5%-1.75% in three consecutive decisions in 2019 as a mid-cycle adjustment. The COVID-19 crisis pushed the FED to further decrease the rate on March 13th and March 16th, 2020 to the range of 0%-0.25%. The 2022 crisis is marked with raging inflation and the FED started with increasing rate cycle throughout the 2022, for seven consecutive times. The last decision was made on December 14th, 2022 and the rate was set to the level of 4.25% to 4.5% (Forbes, 2023). The FED and ECB rate hikes will be continued in the 2023. The case with ECB is a bit different. From the 1999, when the euro currency was introduced and the ECB started to operate, all until this day and age, which marks the beginning of 2023, the ECB changed its key interest rates 54 times and the FED changed its federal funds rate 68 times (FRED & Eurostat, 2023). The difference of only fourteen changes shows the tendency of the ECB to look more alike the FED in frequency of rate changing policy. Among these 54 changes, the highlights are the dot-com crisis, the 2008 crisis, the European sovereign debt crisis, COVID-19, and the 2022 war conflict. Eurostat, 2023, shows that the main refinancing operations rate was increased seven consecutive times in 2000, from 3.25% to 4.75%. From May, 2001 till the June, 2003 the rate was decreased seven consecutive times, the minimum amounting to 2%. Prior to the 2008 collapse, the rate was increased nine times, until it levelled the 4.25%. Until the mid-2009 it was decreased to 1%. The booming 2008 crisis was interrelated with the European sovereign debt crisis which accumulated in 2009. Both of these crises led the policy creators to drastically decrease the MRO rate. The MRO was set to 0.75%, then to 0.5%, 0.25%, 0.15% and ultimately to 0%. The rate was increased as of the July 27th, 2022, it was set to 0.5%. Three more rate hikes took place in 2022. The rate was increased to 1.25%, then 2%, and lastly, as of December 2022, to 2.5%. The deposit facility rate and the marginal lending facility rates were also a subject to change during all of these mentioned crises (ECB Statistics, 2023). It is very important to highlight the times of the negative eurozone interest rates. These are the times after the European sovereign debt crisis hit, after the year 2009. The eurozone went through almost a decade of negative interest rates. The

ECB's deposit facility rate is the best representation of such interest rates. By looking and analysing the last two reference points (Eurostat & ECB Statistics, 2023), all three key interest rates were consecutively decreased as a response to the 2008 crisis and the newly emerged European crisis. Years after, rates were declining and the deposit rate fell to 0% on the July 11th, 2012. It was not changing for two more years. In the mid-2014 the deposit facility rate was set to -0.10%, for the first time ever. It continued to decrease and fall more into negative area (lowest -0.5%) all until the mid-2022, when it was increased to 0%. As of December, 2022 it is set to 2%. Years of negative interest rates were set as the eurozone feared deflation. As the European debt crisis was spiralling into deep vicious negative cycle, for years after 2009, the eurozone policy creators made a decision to enter a cycle of negative interest rates in order to spur economic growth and catalyse business investments. The marginal lending facility rate in July, 2022 was increased from 0.25% to 0.75%, then to 1.5%, 2.25% and 2.75% as of December, 2022.

2.2 ECB vs. FED announcements and credibility issue

To build public trust requires high levels of transparency. Policy creators, as the main figure representatives of the government, have the task to be responsible and transparent to public as they strive to maintain public security. They are representatives of public interests. They are liable to bring measures on behalf of the best public interest, with their knowledge and expertise. By doing so, policy creators increase their credibility, they increase credibility of institutions they work for and maintain stability within the society they represent. The credibility is based on trust, whereas trust is earned on honesty and transparency. When we talk about government, we talk about politics and political structures. Central banks are very specific bank forms, completely different than commercial banks, as in the functions and operations, mostly so in the core fundament. They are the state institutions, they act as the ultimate supervisors of all other banks and depository institutions, but most importantly, they are exclusive monetary policy creators, acting in the name and on the account of the state monetary interests by protecting domestic currency value, directing money supply, keeping price levels stable and protecting the sovereignty of domestic monetary system. Involvement of political structures in central banking should, at least theoretically, be as low as possible. Central bank is the institution that should be completely politically independent. However, reality teaches us that practice is always somewhat different. Each form of such involvement in central banking operations raises a conflicting atmosphere within the public circles. Any such form of conflicting debates might easily lower the credibility of the central bank operations. Research on this topic confirms this reasoning. Binder (2021) points out exactly this issue. The paper highlights that even banks with high level of independence are often exposed to political pressures and almost always for looser monetary policy. It is even pointed out that 10% of central banks, on an annual base, face political pressures. Moreover, evidences show that high pressures are strongly correlated with cycles of high inflation rates. This is very concerning cognition, which divergently relates to positive credibility outlook.

It is, nonetheless, observed that both Federal Reserve System and the European Central Bank do exhibit an overall high levels of data transparency. Therefore, the high credibility rate of their respective institutions. The main factors to the level of credibility, for both banks, are exposed in their overall stable political fundament, higher living standards, economic growth rates, higher incomes, developed financial markets and higher accumulated wealth compared to other economies globally. Besides, as the two most important global monetary policy and monetary system participants, both not only carry responsibility towards domestic economy, but global as well. Particularly towards all those economies whose domestic currencies are pegged to either US dollar or euro. It is, though, observed through FED's statistics that trend of data transparency and public announcements did increase over time. The period of 1990s marked a breaking point. From the mid-1990 transparency of data started to increase. Public and media pressures during the ongoing crisis at the time, pushed the institution to publicly introduce measures. They called for more responsible behaviour of the FED towards the public. The FED responded positively, exhibiting over years an increased trend of overall public trust and credibility. Announcements are done in a timely-manner, regular press conferences are held, data and reports are public. The ECB has shorter history compared to the FED; therefore, it did not come across such challenges. Current ECB data, as well as historical ones, are timely-reported. The same goes for public appearance, announcements, press conferences, required reports and outlooks based on future expectation and measures. The ECB exhibited a disciplined approach from the very beginning of operation, in the 1998. The reason might be found in a long-time battle for the common currency within the Union.

3 INFLATION AND THE 2022 CRISIS

Inflation surge in the 2022 was exacerbated by the war conflict between Russia and Ukraine. The global economic outlook was still on the shaking grounds at the beginning of 2022, due to post-Covid aftermath. When collided with the war, on February 24th 2022, the inflation rate started to increase heavily. Inflationary environment is a serious threat to all financial markets. The intercorrelations among financial markets are very complex in inflationary and deflationary environments, and should be analysed independently. However, when inflation rates started to increase rapidly at the beginning of 2022, commodity market was first in the row. The oil, gas, and wheat prices started to experience high volatility.

As the European Union strongly disapproves of Russian invasion on Ukraine's sovereignty, the sanction plan was at discussion table shortly after the start of the conflict. The Ukraine has always been the European Union's target of future expansion on the Eastern Europe. In order to help Ukraine, sanction plan was in effect from the second quarter of 2022. The US, as the main EU ally, and the major global political figure, decides to stand behind the Ukraine and starts with sanction plan, as well. Many other countries followed. Aim of the sanction plan was to destabilize Russian economy and decrease its military power. Core base of Russian economy is extremely leaned on the energy industry. The European Union, together

with the United Kingdom, decided to withdraw Russian natural gas and oil imports. The two, with the United States, decided to stop the imports of oil and put the ban on all oil refined products. As the EU is the main importer of Russian gas and oil, decisions were not easy to be made. Commodity market was heavily hit, prices of oil and gas started to boom pushing the inflation steadily upwards. On the other side, around 30 countries worldwide depend on Ukrainian agriculture and grain raw products (wheat, maize and sunflower oil). Devasted Ukrainian land, heavily impacted by the war conflict, lost the potential to follow with export trends. World countries depending on their agricultural raw products were strongly affected by market price volatility of these commodities. Price volatility of all these commodities transmitted to other markets, consequently further pressuring inflation outburst. In order to analyse the inflation effect, commodity market price deviations are the first to start with.

3.1 The 2022 inflationary environment

While the European Union is the most dependant market on Russian energy, the European energy prices are expected to fluctuate as long as the scarcity of natural gas and oil problem is overcome. Due to high rate of energy resources trade between Russia and the EU, imposed sanctions are a shock to both economies. The United Kingdom imported only a small amount of Russian natural gas exhibiting a lower inflationary impact than other economies. Another high shock to Russian economy followed when the US, the EU and the UK imposed hard financial measures against Russian banking and financial system pushing Russia out of the international financial messaging Swift system. All of these and other imposed sanctions did leave a high negative imprint on Russian economy. Even though the exchange rate between the Russian ruble and the US dollar was stable in 2020 and 2021, it sharply depreciated from March 2022. Yet, the war continued and still does not seem to be coming to an end. New sets of sanctions are in preparation, and the global economic outlook is not coming to the stable grounds within the nearest future. Russia turned to other countries when it comes to energy exports. The Bloomberg data (2023) show that the price of Russian oil sharply decreased from March 2022, from around 100 US dollars per barrel to slightly above 40 US dollars per barrel by the end of 2022. China, India and Turkey took the advantage of these prices. These three countries are now Russia's three largest energy export markets, especially India. The data show that Russian energy export to India increased from circa 50,000 oil barrels per day to 1.5 million oil barrels per day. China's import trend of Russian oil was deviating slightly between 600,000 and 900,000 barrels per day before the war started. After the start of conflict, imports increased from 800,000 to 1.2 million oil barrels per day. While the UK completely stopped their imports of Russian oil by the beginning of December 2022, the EU announced complete cut off by March 2023. Since it was highly dependent on Russia-energy sources, the cut back had to be done slowly, cutting back two-thirds of imports by the end of 2022. Countries like Hungary and Slovakia, still, remain fairly dependant on the Russian energy supply. Throughout the EU, prices of energy products (oil and gas prices) increased sharply. Slighter, yet firm enough shock was felt through the United States and

other countries that were oil importers from Russia. OPEC, and other global oil producers had to cut their production in order to act upon oil price stabilization. International Energy Agency (IEA) calls oil-rich countries, such are the United Arab Emirates, Saudi Arabia, Venezuela, and others to start increasing their oil exploitation and production. Oil and gas reserves are at the verge of diminishing, and alternative trade agreements have to be set up in order to substitute all Russia-dependent countries with new sources of energy supply.

When it comes to Russian gas exports, the Bloomberg data show that the largest European import country is Germany, then Italy, Netherlands, France, Poland, Hungary, Spain and Belgium. Germany was dependant on almost twice as much billions of cubic meters Russian gas imports than Italy. Data for 2021 show that 40% of Russian natural gas exports was supplying the European market. Data from the Energy Information Administration (EIA), 2021, while the data for 2022 are still not available, show that in that year the largest world oil producer were the United States, by producing 18.86 million barrels per day (bpd), the number increased by 266,000 produced barrels per day from 2020. The biggest oil-producing state in the US is Texas, producing almost four times as much barrels per day than the second state on the list, which is New Mexico. After the US is Saudi Arabia, with 10.84 million produced barrels per day. As Russian economy, so is the Saudi Arabian economy highly leaned on the gas and oil exports. Slightly above 50% of their gross domestic product is based on energy product exports. Russia took the third place on the scale with produced 10.78 million bpd in the 2021. Canada took fourth place by producing 5.56 million bpd in the same year. Fifth is China with 4.99 million bpd produced in 2021. After China come Iraq (4.14 million bpd), the United Arab Emirates (3.78 million bpd), Brazil (3.68 million bpd), Iran (3.45 million bpd), and Kuwait (2.72 million bpd). The natural gas 2021 production data, on the other hand, show that again the US took the first place, by producing 934.2 billion cubic meters of natural gas for that year. Russia followed with the production of 701.7 billion cubic meters for the same year, then Iran with 256.7 billion cubic meters production, China with 209.2 billion cubic meters and Qatar with 177 billion cubic meters. After the top five, on the list are also Canada with 172.3 billion cubic meters of natural gas production in 2021, then Australia with 147.2 billion cubic meters, Saudi Arabia with 117.3 billion cubic meters, Norway produced 114.3 billion cubic meters and Algeria 100.8 billion cubic meters. The last on the list are: Turkmenistan producing 79.3 billion cubic meters of natural gas, Malaysia with the level of production reaching 74.2 billion cubic meters, Egypt with 67.8 billion cubic meters of produced amount and Indonesia producing 59.3 billion cubic meters in 2021 (Statista, 2021).

Next to energy products price volatility, additional wave of inflationary shock was induced by agricultural raw products scarcity due to cut-off Ukrainian exports. This shock added towards scarcity of such resources within importing countries and pushed the price level up. Decreased supply for raw agricultural products, such as sunflower oil, wheat, maize, barley, and rapeseed caused a cost-push effect on inflation rates. Prices for such raw products rose, and cycled the prices of all other products, whose final production is based on such grains,

upwards. Such goods represent the necessity food products which are the base of an average consumer basket and are necessary for an average human to survive. They are the base of an average inflation index rate calculations. The Eurostat Art. (2023) shows that the European cereals import, both from Ukraine and Russia, used to be a one-third of all cereal imports in the EU; 28.8% from Ukraine (1.7 billion euros) and 4.8% from Russia. Data are for 2021. Vegetable and animal oils and fat are the second largest EU imports of agricultural products from these countries; 14% from Ukraine and 2% from Russia. The third place take oil seeds and oleaginous fruits with import weight of 9.9% from Ukraine and 2% from Russia. Then follows vegetable plaiting materials with import weight of 6.9% from Ukraine and 5.1% from Russia. Other similar products from this category follow, but in a far smaller weight.

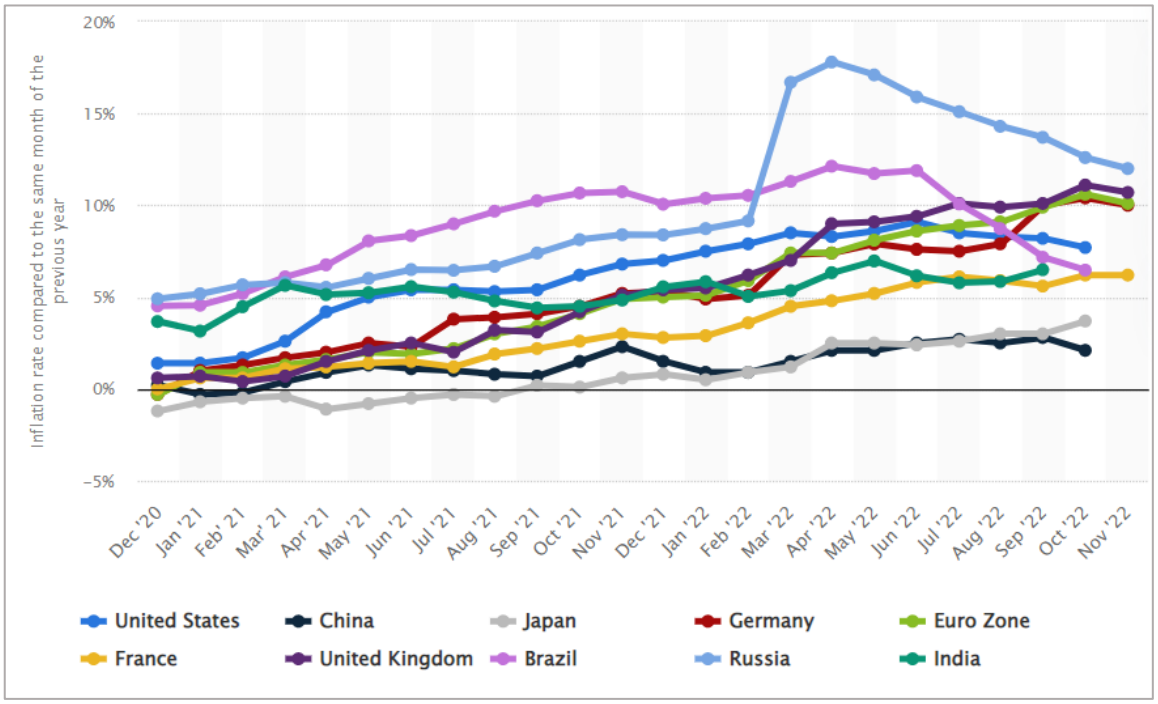
Worldwide decades-long more and more dominant globalization effect led towards the outcome that just about all countries globally experienced inflation outburst within the 2022 year. Developing countries have had such challenges in the nearest past conquering new tests in 2022; whereas, the developed countries confront such level of soaring price increase rate, on average level, for the first time from 1980s. Emerging markets mark substantial hike in price levels from 1990s. Commodity market volatility rates, in a fast-speed rate, passed over to other markets, especially foreign exchange, stock, and bond markets. The effect on the volatility rates of these markets was an immediate shock. Overall financial market and financial system destabilization, and depreciation of local currencies call for drastic and serious measures. Even though it seems that economies have been taking serious measures against soaring price levels, deeper and more concise analysis will be run in the future years.

Data for the monthly worldwide inflation rates, show that the highest inflation, in February 2022, was exhibited by Brazil (10.54%), then Russia (9.15%), the United States (7.9%), the United Kingdom (6.2%), the Eurozone (5.9%) – were Germany exhibited 5.1% and France 3.6% inflation level and India (5.04%). China and Japan were exhibiting only 0.9% rate of inflation. March 2022 is already one month into war conflict, where the leading inflationary pressure is observed in Russia. Its inflation hikes to 16.7% for the same period. This is 82.5% of inflation rate increase compared to one month prior. Other countries follow with inflation increase; however, with smaller percentage rate increase compared to Russian economy. For example, Brazil for the same month takes second place with inflation rate of 11.3%. The US is third (8.5%), then the Eurozone (7.4%) – Germany (7.3%) and France (4.5%), then the UK with the rate of 7%, India (5.35%), China (1.5%) and Japan (1.2%). April of 2022 marks the milestone month for Russian inflation rate. Although, March 2022 was the month of the highest price level increase for Russian economy, Russia reaches its highest inflation rate in April, 2022. It marked the level of 17.8%. Inflation level for Brazil in April 2022 amounted to 12.13%. Volatility of price rates of Russia and Brazil, as the two emerging markets, continued to exhibit slow decreasing pattern from May 2022 onwards. In October 2022, Russian inflation was 12.6%, Brazil marked the level of 6.47%. Inflation rate of Germany exhibited steady increase until October 2022, when it hit 10.4%. November 2022 showed a very slight decrease, the rate was 10%. France, as well, exhibited a steady pattern of inflation

incline marking the rate of 6.2% in November 2022. The Eurozone, as the whole, marked substantial inflation increase with a steady-increasing trend from January 2021 until the end of 2022. The rate of inflation for Eurozone in January 2021 was 0.9%, whereas November 2022 exhibited the level of 10.1%. This is, historically, an enormous inflationary pressure for the Eurozone, especially for Germany. The UK exhibited historically high inflation rates.

Inflation level for Germany, in November 2022, was 10%, for the United Kingdom 10.7%. Russia marked 12%, for the same month. China and Japan, hit the inflation levels of 2.1% and 3.7% in November 2022, respectively. Inflation rate for the US was the highest in June 2022, deviating from 9% to 9.2%. Historical data for the US inflation levels show that the US inflation rate was, already, substantially shaken by the COVID-19 crisis. The 2022 crisis altered already high inflation level and added to its further boost. Throughout the 2022 year, the US inflation deviated in the range of approximately 7.7% and 9.2% rate. In October 2022 data show that the country's inflation rate marked the level of 7.7% (Statista, 2023). Figure 3 shows visual presentation of the global inflation rates in developed and emerging markets.

Figure 3: Monthly inflation rates in developed countries and emerging markets



Source: Statista (2022).

Note: Inflation rates are monthly rates, compared to the same month of the previous year.

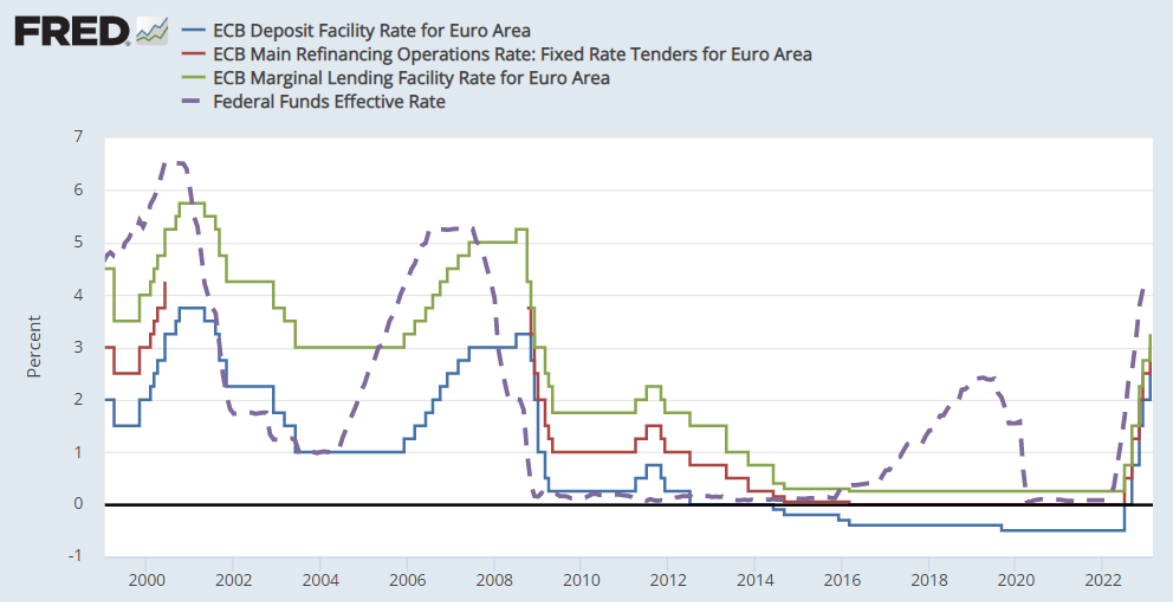
When analysing drivers of inflation rate increase and historical rate trends among the United States and the Eurozone, crucial differences exist. First of all, one of the main differences is that the EU is high net-importer of the energy products, whereas the US is high oil and gas producer itself. However, the US has a very diversified trade, both regarding imports and exports of energy products. Although, the imports of Russian oil and gas were present in 2021 and before 2021 in the US, they did not carry substantially high weight in energy net

imports to impact the US inflation as much as they impacted the Eurozone and the EU rate of inflation. Secondly, both economies mark different pre-war inflationary levels. The US shows to have a higher price level pressure before March 2022 than the Eurozone does, as an aftermath of Covid crisis (check Figure 3). Among the Eurozone countries, the highest soaring price levels are observed in Germany. It is the highest inflation rate Germany has witnessed after their post-war period. The main reason is its extremely high dependency on Russian energy, one of the highest in the Europe. Rigorously fast-paced reduced supplies of energy boosted the prices for such products upwards and pushed housing and other costs up.

3.2 Interest rates hikes

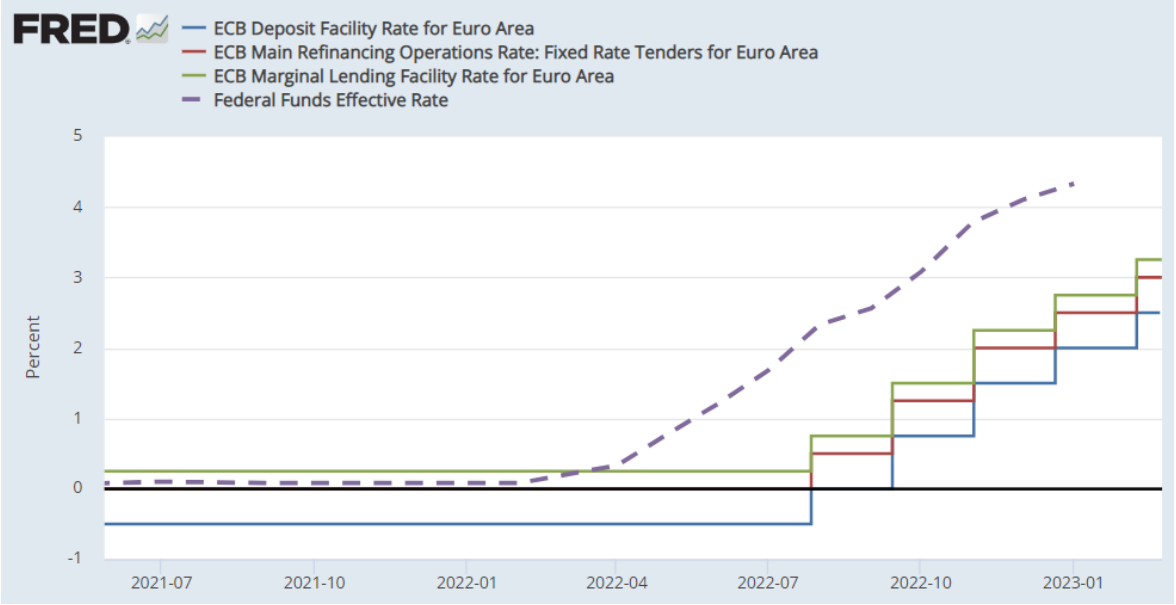
Using key interest rates, as the main monetary aggregates, to target the inflation level of 2%, by both FED and ECB, is the most direct measure at hand against highly volatile prices. Higher interest rates imply higher borrowing costs, thus causing declined consumer tendency to spend. Consumption, as one of the main gross domestic product factors, when decreased acts upon slowing economic cycle. By slowing the economic activity, reduced money supply consequently pushes inflation rate down. Indeed, the obvious role of the rate of interest is to clear the money market and, in doing so, contribute to the regulation of economic activity (Rochon & Setterfield, 2008). Figures 4 and 5 show policy rates' movement over time.

Figure 4: FED and ECB key interest rates over time, 2000-2023



Source: FRED Statistics (2023).

Figure 5: FED and ECB key interest rates over time, 2021-2023



Source: FRED Statistics (2023).

The Table 1 exhibits all the historical key interest rate changes by the European Central Bank and the Federal Reserve System from 1998 until 2023. Table marks interest rate hikes with the darker grey colour, and interest rate decreases with the lighter grey colour. Light orange colour marks dates of changes in the year 2022 and at the beginning of the 2023 year. It is fairly observable that the FED has had more interest rate changes than the ECB within the chosen time span, from 1998 until the beginning of 2023. There are twenty-two more federal fund rate changes in comparison to the ECB key interest rate changes. The ECB sets three interest rates, the main refinancing operations rate (which is comparable rate to the US federal funds rate), then the deposit facility rate and the marginal lending facility rate. All three rates follow the same increasing/decreasing pattern, except for the 9th and 15th October, 2008. The 9th October 2008 followed with the stagnation (i.e., no change) of the main refinancing operations and the deposit facility rates, and decrease of the marginal lending facility rate. The 15th October 2008 observed decrease of the marginal lending facility rate and the main refinancing operations rate, whereas no change in the deposit facility rate took place. The European sovereign debt crisis is observed through low and negative key interest rates. It started in the year 2009, nearly after the 2008 stock market crash. Consequences were felt years after, slightly over the whole decade, all until the latest 2022 crisis. If one looks at the deposit facility rate, one can observe that it was negative all until the 27th July, 2022. The new financial crisis stopped decade of historically low interest rates and years of negative deposit facility rate. The federal funds rate, on the other hand, exhibits changes which did not enter into negative bound. From 16th December 2008, the FED started to set the federal funds rate within the range level. This option led towards a more flexible leverage of the financial system and realization of the main monetary policy goals. Such system of range-form rates exhibited a positive effect during the 2008 crisis and is left onwards, even until today. Key interest rates in Table 1 are exhibited in percentages per annum.

Table 1: Key interest rate changes through 1998-2023, ECB and FED

The European Central Bank				The Federal Reserve System			
When	Deposit facility	Main refinancing operations	Marginal lending facility	When	The federal funds rate	When	The federal funds rate
1999-04-09	1.50	2.50	3.50	1998-09-29	5.25	2017-03-16	0.75 - 1.00
1999-11-05	2.00	3.00	4.00	1998-10-15	5.00	2017-06-15	1.00 - 1.25
2000-02-04	2.25	3.25	4.25	1998-11-17	4.75	2017-12-14	1.25 - 1.50
2000-03-17	2.50	3.50	4.50	1999-06-30	5.00	2018-03-22	1.50 - 1.75
2000-04-28	2.75	3.75	4.75	1999-08-24	5.25	2018-06-14	1.75 - 2.00
2000-06-09	3.25	4.25	5.25	1999-11-16	5.50	2018-09-27	2.00 - 2.25
2000-06-28	3.25	4.25	5.25	2000-02-02	5.75	2018-12-20	2.25 - 2.50
2000-09-01	3.50	4.50	5.50	2000-03-21	6.00	2019-08-01	2.00 - 2.25
2000-10-06	3.75	4.75	5.75	2000-05-16	6.50	2019-09-19	1.75 - 2.00
2001-05-11	3.50	4.50	5.50	2001-01-03	6.00	2019-10-31	1.50 - 1.75
2001-08-31	3.25	4.25	5.25	2001-01-31	5.50	2020-03-03	1.00 - 1.25
2001-09-18	2.75	3.75	4.75	2001-03-20	5.00	2020-03-16	0.00 - 0.25
2001-11-09	2.25	3.25	4.25	2001-04-18	4.50	2022-03-17	0.25 - 0.50
2002-12-06	1.75	2.75	3.75	2001-05-15	4.00	2022-05-05	0.75 - 1.00
2003-03-07	1.50	2.50	3.50	2001-06-27	3.75	2022-06-16	1.50 - 1.75
2003-06-06	1.00	2.00	3.00	2001-08-21	3.50	2022-07-27	2.25 - 2.50
2005-12-06	1.25	2.25	3.25	2001-09-17	3.00	2022-09-21	3.00 - 3.25
2006-03-08	1.50	2.50	3.50	2001-10-02	2.50	2022-11-02	3.75 - 4.00
2006-06-15	1.75	2.75	3.75	2001-11-06	2.00	2022-12-14	4.25 - 4.50
2006-08-09	2.00	3.00	4.00	2001-12-11	1.75	2023-01-31	4.50 - 4.75
2006-10-11	2.25	3.25	4.25	2002-11-06	1.00		
2006-12-13	2.50	3.50	4.50	2003-06-25	1.00		
2007-03-14	2.75	3.75	4.75	2004-06-30	1.25		
2007-06-13	3.00	4.00	5.00	2004-08-10	1.50		
2008-07-09	3.25	4.25	5.25	2004-09-21	1.75		
2008-10-08	3.25	4.25	4.75	2004-11-10	2.00		
2008-10-09	3.25	4.25	4.25	2004-12-14	2.25		
2008-10-15	3.25	3.75	4.25	2005-02-02	2.50		
2008-11-12	2.75	3.25	3.75	2005-03-22	2.75		
2008-12-10	2.00	2.50	3.00	2005-05-03	3.00		
2009-01-21	1.00	2.00	3.00	2005-06-30	3.25		
2009-03-11	0.50	1.50	2.50	2005-08-09	3.50		
2009-04-08	0.25	1.25	2.25	2005-09-20	3.75		
2009-05-13	0.25	1.00	1.75	2005-11-01	4.00		
2011-04-13	0.50	1.25	2.00	2005-12-13	4.25		
2011-07-13	0.75	1.50	2.25	2006-01-31	4.50		
2011-11-09	0.50	1.25	2.00	2006-03-28	4.75		
2011-12-14	0.25	1.00	1.75	2006-05-10	5.00		
2012-07-11	0.00	0.75	1.50	2006-06-29	5.25		
2013-05-08	0.00	0.50	1.00	2007-09-18	4.75		
2013-11-13	0.00	0.25	0.75	2007-10-31	4.50		
2014-06-11	-0.10	0.15	0.40	2007-12-11	4.25		
2014-09-10	-0.20	0.05	0.30	2008-01-22	3.50		
2015-12-09	-0.30	0.05	0.30	2008-01-30	3.00		
2016-03-16	-0.40	0.00	0.25	2008-03-18	2.25		
2019-09-18	-0.50	0.00	0.25	2008-04-30	2.00		
2022-07-27	0.00	0.50	0.75	2008-10-08	1.50		
2022-09-14	0.75	1.25	1.50	2008-10-29	1.00		
2022-11-02	1.50	2.00	2.25	2008-12-16	0.00 - 0.25		
2022-12-21	2.00	2.50	2.75	2015-12-17	0.25 - 0.50		
2023-02-08	2.50	3.00	3.25	2016-12-15	0.50 - 0.75		

Source: European Central Bank & Federal Reserve System (2023).

Note: Table was created by the author and interest rates are exhibited in percentages per annum.

4 METHODOLOGY

Global stock market price volatility increased as energy resource scarcity shock was imposed by strict sanctions against Russian economy, in an attempt of allies to weaken Russian war power. Trade agreements were torn apart between Russia and opposing allies creating shock impact on energy industry worldwide. Prices of energy products increased heavily as trade resources were stopped and no other supply inflow was settled. Energy price shock increase was the highest in the second quarter of 2022. The lag between trade deterioration and settlement of new trade agreements caused a huge disbalance of energy market prices and added up towards fast-growing inflation rate. Market disturbances are still present since new agreements have not been settled. Many countries, especially the European economies, are on usage of their energy reserves. Reduced supply for energy products still does not let the prices to blow out. Scarcity creates an overall market panic and keeps prices on high alert.

This thesis connects and analyses all these concerning points. It looks at the 2022 crisis from the point of monetary policy reaction to highly soaring inflation rates. It analyses the short-term effect of central banks' policy measures on stock market performance and rate of stock market volatility. The aim is to answer, in an already inflationary boosted frame, how much of a shock were the ECB's and FED's announcements on stock market price rates.

The methodology for such analysis is the event-study methodological framework. This type of analysis is based on determining statistically significant impact of an event on stock price changes. It is a short-term measure focusing on an immediate and instant effect analysis on internal market movements. Subject to event can be many different factors; however, factors that characterize event base of this research thesis are externally-oriented (they do not come from within the market itself), macro-oriented (key interest rates are macroeconomic money aggregates) and partially-exogenous (the events are not completely unexpected).

4.1 Data set overview

Data are collected from the Bloomberg Terminal real-time database[3]. The main databases are historical stock index performances. This research thesis is based on historical prices of two stock indices, the S&P 500 and Europe STOXX 600. The reason for choosing these two index forms is based on the analysis of two stock markets, the United States stock market and the European stock market performances. The S&P 500 index, in this research thesis, is a representative of the US stock market and the Europe STOXX 600 is a representative of the European stock market. Each of these two indices, as the market capitalization weighted indices of the largest companies within their respective markets having the most companies

[3] The Bloomberg Terminal real-time database used in this research paper is the computer software system owned by Bloomberg Inc., whose lessee is the School of Economics and Business, University of Ljubljana.

listed, are the best-chosen representatives of each stock market, respectively. Historical price level databases are collected on the daily-period base, each in their own currencies. S&P 500 index prices are expressed in US dollars, whereas the Europe STOXX 600 index prices are expressed in euros. The same software is used to collect data on commodity and bond prices, foreign exchange market data for the US and the EU, as well as data on emerging markets. Data on different industry sectors are collected, their weights and market capitalization data. Industry prices are collected on the daily basis, as well. Stock returns, statistical computing, statistical analyses, estimations and inferences are all done via R programming environment.

4.2 Event study methodology

Event study is the analysis used to measure the effect of an economic event on the value of a firm or market as a whole. It is usually used in finance and accounting, but in economics field as well. Many different events are on the spectrum of event study analysis, from both firm internal to firm external events. For example, earnings announcement, resignation of firm manager, mergers and acquisitions, dividend announcements, security issuance, wage decrease or increase, all to higher unemployment rates, strikes, government change, political increased insecurity, changes in regulatory environment, inflation increase, deflation, lack of resources on the market, hindered economic growth, increased tax rates, decreased value of currency, common currency change, war and military conflicts, and many other events.

First papers on event study analysis were introduced in 1930s; however, more developed and more modern event study methodology relates to 1960s. First such research was based on the examination of the relationship between earnings residuals and price residuals. The goal was to challenge previous accounting analyses with a new approach resulting in core findings which opened a new path towards accounting and capital market research forms. Ball and Brown (1968) were pioneers in new and modern event study approach arguing that such analysis takes into account a significant source of knowledge of the world. They argued that previous analyses forms ignored the extent to which the predictions of the model conformed to observed behaviour. This work was a very important foundation of a modern capital market research, because it affirmed the value of financial statements as a research tool (Kothari, 2001). Another pioneer research paper to modern event study methodology is the paper by Fama, Fisher, Jensen and Roll (1969). Fama, Fisher, Jensen, Roll (1969) work was based on the effect of new information to common stock price movements. They examined the process by which common stock prices adjust to the information that is implicit in a stock split. These two research papers set the core fundament for event study analyses. It is believed among researchers that FFJR (1969) paper set the standard for researching the effect of changes in company value based on the specific event (Kothari, 2021).

Capital market analyses are highly based on the event study methodology when information effect on price movements is tested. In practice, event studies have been used for two major

reasons, one being to test the null hypothesis that the market efficiently incorporates all sets of available information, and the second to examine the impact of some events on the wealth of the firm's security holders under the maintained hypothesis of market efficiency, at least with publicly available information (Binder, 1998). In finance theory, efficiency of capital markets is a very important premise. This premise is based on the assumption that each and every capital market asset price incorporates all publicly available information sets. Every deviation from such a premise represents an instant shock to the market and is momentarily observed in asset price change. Such a change can be most efficiently analysed by the event study analysis. Event study approach is an analysis of an instant shock caused by the event, which can be performed both on short-term and long-term time horizon. Moreover, event studies focusing on long-term horizons following an event can provide key evidence on the capital market efficiency (Brown & Warner, 1980, and Fama, 1991). Even though the literature on the event study analysis is abundant, its development process is not nearing the end phase. Empirical evidences show that the short-term time horizon analysis provides far more reliable methodology; whereas the long-term horizon analysis, although improved, still holds many limitations (Kothari & Warner, 2006). This methodology is based on roughly seven-step approach to determining the real effect of the new information, i.e., the event, on the stock price movements. The step-approach is explained in detail in the 4.2.2 sub-chapter.

4.2.1 Literature on the event study methodology

The literature on event study methodology, within the scope of finance and economics, offers an abundant set of academic papers. Although the first papers on event study analysis were introduced in 1930s, more modern-approached event study methodology papers date back to 1960s. Research papers leaving the most significant impact, among others, are the papers of Ball and Brown from 1968 and Fama, Fisher, Jensen and Roll from 1969. Both of these works represent the fundamental theoretical and empirical base for other future papers and researches. In this research thesis, both of these works are used as one of the main references. Especially relevant for this research thesis is the research work of Fama, Fisher, Jensen, Roll, (1969), which is the first one to use the event study methodology to test the effect of new information set on the stock price behaviour. The period of 1970s was the period of setting the event study methodology into the core of financial empirical analyses. All five leading journals, the Journal of Finance, the Journal of Business, the Journal of Financial Economics, the Journal of Financial and Quantitative Analysis, and Review of Financial Studies included some of the most important works on this topic. The same is applicable even until this day and age where event study papers are found to be in increasing trend. Another group of papers, that immensely helped in theoretical development of this very thesis, is written by Brown and Warner in 1980 and in 1985. Both papers are, again, focusing on the event study analyses in measuring stock and other security price performances. The latter, nonetheless, is based on event impact of daily stock returns. MacKinlay (1997) paper is used for more in-depth theoretical analysis and equation derivations. Papers of Fama, from 1970 and 1991, brought towards a higher understanding of efficient markets and their fundamental settings.

Fama (1995) paper provided deeper understanding of the stock market price movements with the focus on random walk phenomena which is one of important analysis parts of this thesis. Binder (1985) presents the multivariate regression of the event study and is the fundament to incorporating multivariate regression in this paper, as well. His most famous work from 1998, The event study methodology since 1969, redefines the event study analysis and refers to its most significant developments by looking at improvements in the most critical areas, such are long-horizon windows until late 1990s. Kothari and Warner (2006) paper was an important literature point for development of methodological approach of this thesis and another crucial source of equation derivation for the needs of development of the thesis. Clarke and Schythe (2020) introduced panel data modelling in event study methodology and upgraded differences-in-differences model for abnormal return variation. This source of work was mainly used in upgrading the multivariate regression model of this thesis, which had to be adjusted for the needs of used observables. It was an additional base for formulae extraction. Many other academic papers were used in obtaining both empirical and applied resources on stock market volatility and foreign exchange rates in emerging markets (Walid, Chaker, Masood, Fry, 2011), then on the topic of monetary regimes and inflation targeting (Croce & Khan, 2000), on optimal asset allocation (Jensen & Mercer, 2003), and on intermarket analysis (Andersen, Bollerslev, Diebold, Vega, 2007). The paper of Boyd, Hu and Jagannathan, from 2005, tested for the unemployment news effect on the stock market performance, explaining why negative news tend to impact stock market positively. Jensen (1978) was used as great source of evidences for efficient market deviations. Kothari (2001) researched about capital markets in more depth. Corrado (1989) explained the use and importance of nonparametric tests for abnormal prices. Other referenced papers were used as sources of empirical evidence in terms of inflation volatility, bond yields and interest rate correlation, foreign markets and interest rate hikes, bond and stock price correlation, inflationary environment of emerging markets, commodity prices and rates of inflation correlation, parametric tests, interest rate policies other relevant tested variables.

4.2.2 Steps in the event study analysis

Event study model follows a step-by-step approach analysis. In order to examine behaviour of the returns for a sample of chosen stocks underlying the same set of events, the first step is to define event or events. Event definition implies not only defining the event per se, but also defining the event and estimation windows. When choosing the event or a set of more clustered events, it is important that these new information sets are holding a property of an exogenous variable. Such form of feature implies that event(s) are unexpected. Exogeneity can be full or partial. Full exogeneity represents a completely unexpected information shock with no prior leakages of information to the market or to the firm, for example security issuance or earnings announcements. Partial exogeneity, on the other hand, is the case when changes of company's policy or changes in economy's policy are expected; however, it is unknown when the change will take place. This research thesis takes the approach of analysis based on the assumption of partial exogeneity, since the monetary policy reaction to high

inflation rates was expected; yet, it was unknown when the central banks will start with key interest rate changes, how frequent they will be and in which percentage they will rise. It is of a core importance to observe the exact dates of events and any prior potential information leakages to the public prior to the official announcement. Defining estimation and event windows follows the sequence. Estimation window is the time lag between normal expected returns from the company or the market and a time the news comes in and contamines the data; whereas event window represents the time the news about the event gets in, and is followed by the post-event window phase (Kothari & Warner, 2006). Manipulation of the estimation and event windows is very important in the event study modelling. It applies to increasing and decreasing time lags, which tests for the closer time determinant that is more correlated with the stronger information effect on stock prices. This thesis puts its focus here.

The second step is related to the database selection process. This includes selection process of y-dependent variables, the ones on which the event effect is tested. For stock prices, this thesis relies on the S&P 500 stock index and Europe STOXX 600 index. Historical data time determinant intersects the data statistics between the FED and the ECB at the year point of 1998, the year when the ECB was founded, and follows up until the end of 2022. The next step is calculation of normal returns and calculation of abnormal returns. Normal returns are defined as the average returns that stock markets exhibit in perfect market efficiency when the absence of information exogenous shocks prevails. Models of normal return performance are either statistical or economic ones. Statistical models are derived based on distributional assumptions about returns. Statistical model forms are: constant-mean-return model, market model or different factor models. On the other hand, economic models are based on restricted parameters of statistical models in order to provide more constrained normal return models. The most commonly used economic models are the capital asset pricing model (CAPM) and the arbitrage pricing theory (APT). However, event study methodology empirical evidence does not exhibit any advantage by using economic models over statistical models. The model most used in practice is the statistical market model. The analyses of this research thesis are based on the market model. Abnormal returns, contrary to the normal returns, are returns unexpected of normal average due to information shock. The event study model is focused mainly on the cumulative average abnormal returns (CAAR). The next step focuses on the estimation procedure which estimates parameters of the normal model performance in the estimation window. Following step includes testing procedure. This step includes definition of null hypothesis and determination of techniques for abnormal return aggregation. The next step includes empirical result presentation with a focus on potential diagnostics by checking for outliers. Analysis ends with cross sectional variation in abnormal returns, and conclusion.

4.2.2.1 On normal and abnormal returns

Normal and abnormal returns differentiate in whether the unexpected information shock has affected the market or not. Kothari and Warner (2006) set the framework (no matter if short-term or long-term horizon is used) which is necessary for event-study modelling in order to

provide meaningful basis for assessing the usefulness of event studies. The most important frameworks by them are economic and statistical hypothesis and an objective basis for strong measuring and comparing. In order to reach a clear difference among efficient and inefficient capital markets, Jensen (1978) says that prices reflect information to the point where the marginal benefits of acting on information do not exceed the marginal cost. This is, to say, a more economic-approach definition to market efficiency. Fama (1991) argues that it is not only the ambiguity of market costs (for example, trading costs) that causes the main obstacle to market efficiency inference; yet, it puts a higher concern on the joint-hypothesis problem. Market efficiency, per se, is not testable and it has to be tested jointly with some model of equilibrium, like asset-pricing model. Fama (1991) further argues that when one finds firm evidence on returns behaviour, the way it should be split between market inefficiency or an inadequate model of market equilibrium is ambiguous. For this reason, Fama (1970) divides market efficiency tests in three categories. Those are: the weak-form tests (How well do past returns predict future returns?), semi-strong-form tests (How quickly do security prices reflect public information announcements?) and strong-form tests (Do any investors have private information that is not fully reflected in market prices?), (Fama, 1991). Since the market efficiency theory hypothesis can potentially carry fundamental biases, it is important to highlight that the event-study methodology represents the semi-strong-form test.

Event study methodology examines return behaviour for a sample of stocks experiencing a common type of event. The event study analysis determines t = 0 to be the time of an event. For each stock security i, the return on the stock for time period t relative to the event R_{it} is defined by the main formula:

$$R_{it} = K_{it} + e_{it} \qquad (1)$$

where K_{it} represents the "normal" component of the return. It is expected or predicted return given a particular model of expected returns (either statistical or economic model). Expected return is unconditional on the event, but conditional on other information sets. Event study modelling begins with K_{it} calculation and determination of normal return performance. The R_{it} represents a return conditional on the event, and it is called an observed return, whereas the e_{it} is abnormal return. Abnormal return is the difference between the return conditional on the event and the expected return unconditional on the event. It is represented by formula:

$$e_{it} = R_{it} - K_{it} \qquad (2)$$

where it exhibits a direct measure of the unexpected change in securityholder's wealth in comparison with the event (Kothari and Warner, 2006). The model of normal returns must be specified before abnormal returns are calculated. Abnormal returns are calculated in order to get the cumulative average abnormal return indicator (CAAR). This indicator is important since the abnormal returns within the short-term horizon are prone to biases. This measure, simply put, represents a sum of average abnormal returns over the time period. It is, though, important to emphasize that this research thesis is focused on the short-term horizon. As said,

short-term horizon analysis is highly reliable in comparison with the long-term horizon that still carries many limitations. Short horizon is defined by testing event window from one to few days before and after the event date, up to one-year, long horizon tests one to five years.

4.2.2.2 Market model in-depth

This thesis focuses on the statistical market model for normalization process of the abnormal stock returns. The reason why this model is chosen among other models is predominantly based on assets return relation to the return of the market portfolio. Since this thesis is based on the performance analysis of stock markets of large economies, I find that its normalization with an overall broad market index returns is crucial. Hence, Cable and Holland (2010) outline that practice shows a strong preference in favour of the regression-based models with the market model, generally, outperforming the capital asset pricing model. Also, the main benefit of this model in comparison with other models is the R^2 statistical fit. This, R-squared, measure is the statistical measure of fit indicating how much variation of the dependent variable is explained by the independent variable or more variables in regression modelling. Market model exhibits more preferable R^2 compared to other models. Thus, the decision to choose market model is based on these argumentations.

The fundament of market model is that it relates the return of any given asset to the return of the market portfolio. Market model is explained by the following formula:

$$R_{it} = \alpha_i + \beta_i R_{mt} + \varepsilon_{it} \qquad (3)$$

where $E(\varepsilon_{it}) = 0$, $Var(\varepsilon_{it}) = (\sigma_{\varepsilon i})^2$. R_{it} is the t-period return on asset i, whereas R_{mt} is the t-period return on market portfolio. The zero mean disturbance term is denoted with ε_{it}. Market model parameters are α_i, β_i and $(\sigma_{\varepsilon i})^2$. In order to calculate R_{mt}, broad market indices are used such are ones used in this thesis, the S&P 500 and the Europe STOXX 600. If the market model parameter $\beta_i = 0$, the model equals to the constant-mean-return model. The constant-mean-return model (CMR) is the simplest model; however, the abnormal return variance can be fairly similar to the same of more complex models (Brown and Warner, 1985). Yet, the main improvement of market model over CMR model is found in removing a part of variance of abnormal return that is attributed to the variation in R_{mt}. When the variance of abnormal return is reduced, that leads to increased ability to detect event effects. Hence the R^2 benefit.

Mathematical approach to market model estimation is based on the following process:

$$E[R_{it}|X_t] - r_{ft} = \beta_i[E[R_{mt}|X_t] - r_{ft}] \qquad (4)$$

where r_{ft} defines the risk-free rate related to the time. Risk-free rate is the rate that investor would earn on an investment carrying zero risk over the time. Every investment carries level of different risks; yet, the risk-free rate represents the hypothetical rate of risk where all these

different risks are evaded. Taking on the zero-risk level means that an investor earns a risk-free rate of return on the same investment. The risk free-rate is more of a theoretical concept in finance theory, that helps researchers conceptualize their models and inference about real deviation discrepancies from the perfect risk-free environment. Nevertheless, more practical experiences showed that the way how risk-free rates are chosen is highly connected with the default risk rate. A small intrinsic risk always exists, yet the goal is to choose those rates of return which carry the smallest one possible. Empirical evidences have shown that the best risk-free returns are returns on short-term governments which carry the smallest possible level of default risk. Such examples are returns on the short-term US government bonds, i.e., the US Treasuries, which are secured by the US government. Returns on these bonds carry the risk which tends to zero, since the US government has never defaulted on its debt. On the other hand, European markets use benchmarks like Euribor, or ESTER as risk-free rates. Continuing with the market model estimation, it is important to highlight that the estimation window observations can be expressed as a regression system. Hence the definition of the market model as regression-based model. By applying the ordinary least squares with (L_1) defined number of observations, further estimation process is defined as follows:

$$\mathbf{R}_i = \mathbf{X}_i\theta_i + \varepsilon_i \qquad (5)$$

$$\mathbf{R}_i = [R_{it0+1} \dots R_{it1}]' \, , \mathbf{X}_i = [\iota \mathbf{R}_m], \theta_i = [\alpha_i \beta_i]' \qquad (6)$$

$$\hat{\theta}_i = (\mathbf{X}_i' \mathbf{X}_i)^{-1} \mathbf{X}_i' \mathbf{R}_i, \quad \hat{\varepsilon}_i = \mathbf{R}_i - \mathbf{X}_i(\hat{\theta}_i) \qquad (7)$$

$$\hat{\sigma}^2_{e_i} = (1/L_1 - 2)(\hat{\varepsilon}_i)'(\hat{\varepsilon}_i) \qquad (8)$$

$$\mathrm{var}[(\hat{\theta}_i] = (\mathbf{X}_i\mathbf{X}_i)^{-1}(\sigma_{\varepsilon i})^2 \qquad (9)$$

where σ^2 denotes variance and σ denotes standard deviation of the regression model. By more included observations in the system regression model expands. Empirical analyses are based on multi-variable observations, such is the case with this research thesis. They imply a more complex regression analyses, which will be explained in the following sub-chapters. When normal returns have been estimated, the next step includes aggregation of abnormal returns.

4.2.2.3 Abnormal return aggregation

Abnormality in the stock return behaviour exhibits a deviation from the null hypothesis and implies exogenous effect on the stock market performance. Abnormal return properties are defined in regard to time of an event and analysed stock. Mathematically, they are defined:

$$AR_{it} = R_{it} - \hat{\alpha}_i - \hat{\beta}_i R_{mt} \qquad (10)$$

where AR defines abnormal returns. It is important to outline that such defined property of abnormal returns is in correlation with the market model normal return estimation. This means that they are adjusted and suitable to be used with one another, with an aim of reaching empirically valid inferences. Under the null hypothesis, abnormal return is jointly normally distributed with the zero conditional mean:

$$\sigma^2(AR_{it}) = (\sigma_{\varepsilon i})^2 + 1/L_1[1 + ((R_{mt} - \hat{\mu}_m)^2/\hat{\sigma}_m^2] \quad (11).$$

The $\sigma^2(AR_{it})$ term represents abnormal return conditional variance, which is comprised of variance of the error term from market model and variance due to the estimation error of market model parameters. As estimation window (L) increases, the second term goes to zero. This implies that sampling error diminishes. Under null hypothesis, the distribution of the abnormal return sample is:

$$AR_{it} \sim N\ (0, \sigma^2(AR_{it})) \quad (12).$$

Aggregation of abnormal returns is done across time and across different assets. Aggregation across different securities (in this case, stocks) is defined as cross-sectional aggregation. The time aggregation will be first explained, followed with cross-sectional one. Time aggregation is useful when event is partially anticipated and in cases when the focus is on testing for the market efficiency. Time aggregation considers same variables across time horizon, whereas cross-sectional aggregation uses different variables for a given point in time.

(a) Aggregation of abnormal returns across time

The event study analysis defines cumulative abnormal return, $CAR_i(t_1,t_2)$, for stock i from time period t_1 to t_2 in the following way: $T_1 < t_1 \leq t_2 \leq T_2$. It follows that γ is (L_2 x 1) vector with ones (1s) in positions of event window and zeros (0s) elsewhere, which is determined in the following way:

$$\widehat{CAR}_i(t_1, t_2) \equiv \gamma' \hat{\varepsilon}_i^* \quad (13)$$

$$\hat{\varepsilon}_i^* = \mathbf{R}_i^* - \mathbf{X}_i^* \hat{\theta}_i \quad (14)$$

$$\widehat{CAR}_i(t_1, t_2) \sim N\ (0, \sigma_i^2(t_1,t_2)) \quad (15).$$

Asymptotically, as the number of observations increases, the variance of CAR_i is defined as:

$$\sigma_i^2(t_1,t_2) = (t_2 - t_1 + 1)(\sigma_{\varepsilon i})^2 \quad (16).$$

Such defined aggregation is for single security (one stock) over event time t_1 and t_2 periods.

(b) Aggregation of abnormal returns across different assets

This form of aggregation is an extended version of the previous one. Here, the model takes into account abnormal aggregation form of more different assets over different event periods. The main assumption of this cross-sectional type of aggregation is that abnormal returns of different securities (stocks) do not exhibit correlation among each other. This assumption is valid if there is no clustering of events, meaning there are no overlaps in event windows. If there exists a sample of N events, the model is defined as follows:

$$\bar{\varepsilon}^{*} = \frac{1}{N}\sum_{i=1}^{N}\hat{\varepsilon}_i^{*} \; ; \qquad \mathrm{var}[\bar{\varepsilon}^{*}] = V = \frac{1}{N}\sum_{i=1}^{N} V_i \qquad \textit{(17) and (18)}$$

$$\bar{CAR}_i(t_1, t_2) = \frac{1}{N}\sum_{i=1}^{N} \widehat{CAR}_i(t_1, t_2) \qquad \textit{(19)}$$

$$\mathrm{var}[\bar{CAR}_i(t_1, t_2)] = \frac{1}{N^2}\sum_{i=1}^{N} \sigma_i^2(t_1, t_2) \qquad \textit{(20).}$$

The event study methodology, by Kothari and Warner (2006), is based on establishing whether the cross-sectional distribution of returns at the time of an event is abnormal, i.e., if it is systematically different from predicted. The focus is almost always on the mean of distribution of abnormal returns. Null hypothesis is tested based on whether the mean abnormal return (sometimes referred to as the average residual, AR) at time t is equal to zero. The same aggregation application is valid for the time-series aggregation. It is also of core interest to test whether mean abnormal returns for periods around the event are equal to zero. Namely, MacKinlay (1997) argues that for the variance estimator the assumption that the event windows of the N securities do not overlap is used to set the covariance term to zero. This argumentation relates to (19) and (20) formulae expressions. They are used to further inference about the cumulative abnormal returns and test the null hypothesis of zero returns.

4.2.2.4 Statistical inference and testing procedures

Statistical inferences about the cumulative abnormal returns are drawn from the identity that assumes normal distributional form defined as: $\bar{CAR}_i(t_1, t_2) \sim N\left(0, \bar{\sigma}_i^2(t_1, t_2)\right)$. As already mentioned, this assumes that covariance terms are zero and event windows do not overlap. The null hypothesis, H_0, is set in terms that the event has no impact on returns. MacKinlay (1997) emphasizes that in practice, because $(\sigma_{\varepsilon i})^2$ is unknown, the estimator must be used in order to calculate for the variance of the abnormal returns. It is recommended that the usual sample variance measure of $(\sigma_{\varepsilon i})^2$, from the market model regression in the estimation window, is used and represents an appropriate choice. By using this measure to calculate for

$$\mathrm{var}((\overline{\mathrm{AR}})_t) = \frac{1}{N^2}\sum_{i=1}^{N}\sigma_{\varepsilon_i}^2 \qquad (21a)$$

the null hypothesis can be tested as:

$$\theta_0 = H_0 = \frac{C\bar{A}R_i(t_1,t_2)}{\mathrm{var}\left(C\bar{A}R(t_1,t_2)\right)^{1/2}} \sim N(0,1) \qquad (21b).$$

The distributional result of the null hypothesis is asymptotic with respect to the number of securities N, and the length of estimation window L_1. Model allows for modifications to the form presented, if necessary. If, however, the events are clustered exhibiting some form of cross-correlation among them, empirical analysis should take this cross-correlation into the account. In such case, the standard deviation of optimal cumulative abnormal returns is:

$$\sigma_{C\hat{A}R} = \left[\frac{1}{N}\sigma^2 + \frac{N-1}{N}\rho_{i,j}\sigma^2\right]^{\frac{1}{2}} \qquad (22).$$

When event windows do overlap, covariances between abnormal returns will not be zero and the distribution in (21b) for the aggregated abnormal returns will not be applicable. This problem of clustering is very specific. MacKinlay (1997) further exhibits two possible ways of dealing with clustering feature. One is that the abnormal returns can be aggregated into a portfolio using event time dates and application of the security level analysis to the portfolio. Such an approach can lead towards using the cross-correlation of the abnormal returns. The second methodological option is to analyse abnormal returns without aggregation. Such case considers testing the null hypothesis of the event (that has no impact) using unaggregated security by security data. Example like this can be applied in cases of total clustering. The second term of expression under (22) is included exactly because of the cross-correlation among assets. The effects of even the slightest level of correlation among assets can bias the results, underestimating the standard deviation of abnormal returns within the tested sample.

When dealing with testing procedure of abnormal returns, there are the two most important differences. Namely, two different testing options exist. The first testing procedure is called the parametric test, and the second one is called the non-parametric test. Parametric tests are tests which include assumptions about the abnormal return distribution. The model needs to have parameters set and properly adjusted, hence the name "parametric" tests. Type of the parametric test is the distributional expression of the null hypothesis, under (21b). Contrary to parametric tests, non-parametric tests do not need such assumptions. They are typically used as a robustness check. The most used tests of non-parametric nature in event studies are sign tests and rank tests. They are absolutely free of any AR distributional assumptions. Sign test looks at whether probabilities of positive and negative cumulative abnormal returns are equal. It is based on the sign of abnormal return and requires that abnormal returns (or more generally, that cumulative abnormal returns) are independent across securities and that the

expected proportion of positive abnormal returns under null hypothesis is 0.5, H_0: p = 0.5, (MacKinlay, 1997). If the null hypothesis states that there is a positive abnormal return associated with an event, the null hypothesis is set to be H_0: $p \leq 0.5$, whereas the alternative is set to be H_A: $p > 0.5$ and probability p is defined as $p = pr[CAR_i \geq 0.0]$. In calculating the test statistic, one needs the number of cases where the abnormal return is positive N^+, and the total number of cases N. In this case, test statistic distribution, θ_2, is defined as:

$$\theta_2 = \left[\frac{N^+}{N} - 0.5\right]\frac{\sqrt{N}}{0.5} \sim N(0,1) \qquad (23)$$

where the distributional result is asymptotic. For a test size of (1-α), when $\theta_2 > \Phi^{-1}(\alpha)$, H_0 is rejected. The main weakness of the test is that it may not be well specified if the abnormal return distribution is skewed, as it is usually case with the daily data (MacKinlay, 1997). As a way to overcome this problem, Corrado (1989) introduces a rank test. It is based on the premise that for each asset i abnormal returns are ranked from the lowest to the highest in the event window, where the expected rank of the event day is defined as (L2 + 1)/2 under the null hypothesis. Non-parametric tests, preferably used as a robustness check, are tested separately but should be in conjunction with the parametric tests (MacKinlay, 1997).

The abnormal return detecting is only the first step of the process. Analysis is fundamentally focused on the abnormal returns' determinants within the cross-sectional regression. Within the process the focus has to be set on avoiding the selection biasness, i.e., proper selection of data has to be done maintaining the representativeness of assets' data in the sampling process. Moreover, the performance measure, as is the cumulative abnormal returns measure, has to be set under correct assumptions. The test statistic for this measure by Kothari and Warner (2006) should be computed and compared to its assumed distribution under the null hypothesis that mean abnormal performance equals zero. These tests can be either classical or Bayesian. This thesis considers classical statistical treatment of the data analysis. When the test statistic exceeds the critical value, H_0 is rejected. The critical value, usually, corresponds to 5% or 1% of tail region. The test statistic is defined as:

$$\frac{CAR(t_1,t_2)}{[\sigma^2(t_1,t_2)]^{\frac{1}{2}}}; \qquad \sigma^2(t_1,t_2) = L\sigma^2(AR_t) \qquad (24) \text{ and } (25).$$

The term $\sigma^2(AR)_t$ represents the variance of the one-period mean abnormal return. The test statistics is, typically, assumed to be unit normal in the absence of abnormal performance. Such case is expected since the estimates of standard deviation are used. The last formula, the 25th one, exhibits that longer is the L (observation period) the cumulative abnormal return measure has a higher variance. The CAR variance environment assumes, of course, time-series independence of the one-period mean abnormal return.

When estimating test statistic, two main error inferences can occur, Type I and Type II errors. Type I error occurs if the null hypothesis is falsely rejected, whereas Type II error happens

if the null hypothesis is falsely accepted. When such errors occur, it is important to return to the model and check if the model is correctly specified and if it has the power ability to detect abnormal performance when present. The Type I error is related with the (in)correctly specified model, and Type II error is related to the possible lack of ability of the model to detect abnormality deviations.

4.3 Multivariate analysis

This research thesis empirically analyses the effect of central banks' 2022 announcements on the stock markets' performance. Announcements are based on key interest rate hikes, as the response of central banks to rapidly-increasing inflation rates. Analysed stock markets are mainly the United States and the European stock markets, but the thesis looks into the emerging markets, as well. There is a sequence of consecutive central bank announcements in 2022, from both sides, the Federal Reserve System and the European Central Bank. This implies that not only one event date is of research interest, but a sequence of similar events with different dates. Such implication means that there are multiple independent variables affecting the stock movements. On the other side, stock markets are clustered into different categories, by industry sectors, corporations, different classes, where each sample is a set of many variables depending on these events. The estimation can be done as each independent event's impact on a given sample; yet, such analysis is in its core a multivariate empirical analysis, where the aggregation is run across time and across many different stock prices.

In such an environment, where many dependent variables and many independent variables are interrelated, the analysis which best estimates their linear relation is multivariate data regression analysis. Even though the multivariate regression model coefficient estimates and their standard errors are the same as those obtained using ordinary least squares (OLS) to estimate each individual equation since the same independent variables are used for each security i, Binder (1998), it is of an interest of the thesis to present the multivariate regression as well. No additional efficiency value is reached by using one over the other analysis, the choice is based on the research goal, dataset structure, and other data features. This thesis uses both, the ordinary least squares regression and multivariate regression models.

The multivariate regression analysis, Binder (1985), starts with parameterizing abnormal returns γ_{ia} in the individual return equations using dummy variables D_{at}, which is expressed as:

$$\widetilde{R}_{it} = \alpha_i + \beta_i \widetilde{R}_{mt} + \sum_{a=1}^{A} \gamma_{ia} D_{at} + \tilde{u}_{it} \qquad (26).$$

Each dummy variable, in regression analysis, is the variable which takes values of either 1 or 0 in order to indicate if the certain categorical effect is present or not. In this case, if there

are A announcements, each D_{at} equals 1 during the period of a^{th} announcement and 0 value otherwise. If the case of the same explanatory variables for each N stocks occurs in the return generating process, the system of return equations can be estimated jointly using MVRM:

$$\widetilde{R}_{1t} = \alpha_1 + \beta_1 \widetilde{R}_{mt} + \sum_{a=1}^{A} \gamma_{1a} D_{at} + \tilde{u}_{1t} \quad (27)$$

$$\widetilde{R}_{2t} = \alpha_2 + \beta_2 \widetilde{R}_{mt} + \sum_{a=1}^{A} \gamma_{2a} D_{at} + \tilde{u}_{2t} \quad (28)$$

…

$$\widetilde{R}_{Nt} = \alpha_N + \beta_N \widetilde{R}_{mt} + \sum_{a=1}^{A} \gamma_{Na} D_{at} + \tilde{u}_{Nt} \quad (29).$$

This system, as Binder (1985) further argues, of multivariate regression model allows for the individual abnormal returns, defined with γ, to differ across companies. There are several assumptions implicit to this system. Disturbances are independent and identically distributed within each equation, yet their variances differ across equations. One has to differentiate among the contemporaneous and non-contemporaneous covariances of the disturbances. The contemporaneous covariances of the disturbances are defined as $E(\tilde{u}_{it}\tilde{u}_{jt})$, and covariances of the non-contemporaneous feature are defined as $E(\tilde{u}_{it}\tilde{u}_{j,t-k})$. Assumption has to hold that these terms are nonzero and all zero, respectively. Thus, that contemporaneous covariances of the system disturbances are nonzero, whereas non-contemporaneous ones are all equal to zero. Due to such assumed structure of the variance-covariance matrix of disturbances, this model of regression requires that the observations in each equation are of the same calendar time form. The main advantage of such modelling is found in hypothesis testing. The hypothesis testing implies that heteroskedasticity across equations and contemporaneous dependence feature of the disturbances are explicitly incorporated in the hypothesis tests. The primary interest hypotheses of event study methodology using multivariate regression model are:

1. H_1: $1/N \, \Sigma_i \gamma_{ia} = 0$ |average abnormal return during announcement period a equals zero;
2. H_2: $\gamma_{ia} = 0 \; \forall$ i,a |all abnormal returns equal zero;
3. H_3: $\gamma_{ia} = 0 \; \forall$ i |all normal returns for announcement period a equal zero.

The main difference of these three hypotheses is that the H_2 and the H_3 are joint hypotheses, whereas the abnormal returns are zero either for all firms and all announcements, or for all firms and a given announcement. Tests for the first hypothesis are very similar to the good old Fama, Fisher, Jensen and Roll (1969) methodology.

Even though the multivariate regression model does not differ from the regular OLS model in terms of efficiency, the problems of heteroskedasticity and dependence are avoided. The standard FFJR methodology does not imply independent abnormal return estimators, hence

they are usually not independent or do not have same variances. Binder (1998) points out that abnormal return estimators are frequently either cross-sectionally correlated, different variances across firms are exhibited, are not independent across time for a given firm or have greater variance during the event period in comparison to surrounding periods. All of these issues, together with the time-series dependence problem are avoided using the multivariate regression model. Yet, if the regular OLS regression is still to be performed, many different approaches are at the disposal in order to combat with such issues. The most frequently used method which addresses these problems is the portfolio method. It is based on the premise that average abnormal returns are independent over time span. The average abnormal returns are calculated for all firms with an event during the calendar month. Based on the average abnormal return estimates for the portfolio during the preceding k months, estimator for time series is calculated, namely standard deviation of average abnormal returns depending on time variable for the overall portfolio. Then, the AAR_t estimate is standardized dividing the same with the estimate of the standard deviation. The process is repeated for every sample calendar month, getting the measure of standardized average abnormal returns. The regular test statistic is applied and further the average standardized average abnormal returns calculated. Applying the regular t statistic, it is important to estimate the significance of the cumulative average standardized average abnormal returns. This method deals with issues of cross-sectional correlation (in event time) and with different variances over time. One of the simplest solutions to event-induced heteroskedasticity is that abnormal return estimates are firstly standardized by their estimated standard deviation, then the standard deviation is calculated cross-sectionally in the event period, and the significance of the $ASAR_s$ is tested.

4.3.1 Panel data event study modelling

The event study methodology evolved over time. The Fama, Fisher, Jensen, Roll, (1969) methodological framework set the firm fundament for all further developments. Their model was based on the standard ordinary least squares regression and capital asset pricing forms of modelling and (ab)normal return estimation. Further add-in model features were invented in order to deal with FFJR methodological deficiencies. Some of these were discussed in the previous section of this thesis. Afterwards, multivariate regression model showed to have a range of beneficial features in event study modelling. Test of this regression form exhibited a positive development in event study analysis by not underestimating the standard FFJR approach, but overcoming crucial framework deficiencies. As it is important to point out that methodological approach does depend on dataset properties and research goals, both of these analyses are very dominant in events study researches even today. Development of all these estimation analyses did not substitute one with the other, but provided a wider scope of tools available in researchers' hands to reach as precise analyses as possible. Last decades marked inclusion of panel-data modelling in event study analyses. This trend followed as an upgrade to multivariate regression. Therefore, it is important to present this modelling form, as well. Introduction of panel-data modelling in event studies came as the answer to reducing biases, which arise from multivariate regression when dealing with complex and large databases.

In economics and finance, data sets are often very complex and multidimensional. If we take, for example, a set of multiple countries and decide to analyse interdependence of multiple economic aggregates among them observed for multiple years, we then talk about panel data sets. They are multidimensional and they combine both time series and cross section effect. Such form of aggregation is very common in economics and finance studies. Inclusion of the panel data in event studies brings upon wider dimensional framework and interrelation analyses among series of different events, across many variables, over series of time points. Panel data are defined as longitudinal data sets, due to their cross-sectional and time-series simultaneous effect. One of the most important panel data advantages, (Greene, 2012), is that such form of analysis allows for learning about economic processes while accounting for both heterogeneity across individuals, firms, countries, and other observable variables and for dynamic effects that are not visible in cross sections. This form of modelling implies complex stochastic specifications. Panel data models are an extension to other regression forms. Different models of panel data include pooled regression, the fixed effects model, and the random effects model. The last two models in extended regression forms take dimensions of nonlinear regression, due to multidimensionality effect. The main difference between multivariate regression and panel data is based on linearity and nonlinearity features. The multivariate regression examines liner intercorrelation among several independent variables and sample of dependent variables. However, panel data, as a subset of longitudinal data set, is based on multidimensional interrelation among observations. Another main difference is that panel data models exhibit better robust results, as they allow for heterogeneity across groups and introduce specific effects for individual groups. The multivariate regression does not exhibit these features. When applied to event studies, panel data look at the event(s) from the point of different times-different groups occurrence. Panel data introduction into event studies, developed from the model type, so-called, "difference-in-differences" or the two-way fixed effect model. Models of this form, two-way fixed effect models, naturally are used to examine an impact of experiments, where events are assigned to certain units due to some process beyond the control of the analyst, but owing to some other external factors (political, environmental, etc.), and as such do not assume assignment is random (Clarke & Schythe, 2020). Development and inclusion of panel data into event study analysis starts from here.

4.3.1.1 General panel data modelling framework

The panel data fundamental advantage over a cross section is observed in the higher level of flexibility when modelling differences in behaviour across individual variables. The general modelling framework of this regression, Greene (2012), is econometrically defined as:

$$y_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + \mathbf{z}_i'\boldsymbol{\alpha} + \varepsilon_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + c_i + \varepsilon_{it} \qquad (30)$$

where the $\mathbf{x}_{it}$ includes K regressors, among which no constant terms are included. Individual effect, i.e., heterogeneity feature is $\mathbf{z}_i'\boldsymbol{\alpha}$, where $\mathbf{z}_i$ contains a constant term and a set of group or individual specific variables which may be observed or even unobserved, all of which are

constant over time t. Defined as such, this model looks like a classical regression model. If $\mathbf{z}_i$ is observed for all individuals, the entire model can be treated as an ordinary linear model and fit by least squares. However, the problem arises when the c_i term is unobserved. This form of feature, an unobserved characteristic, is very individual-specific or group-specific, such is the effect of individual skills on their earnings level. Or, for example, the effect of firms' overall labour skill on the stock price. Every panel data analysis main objective is to consistently and efficiently estimate partial effects, defined with β, where the β is defined as $\boldsymbol{\beta} = \partial \mathrm{E}[y_{it}|\mathbf{x}_{it}]/\partial \mathbf{x}_{it}$. Independent variables exhibit a strict exogeneity assumption, defined as $\mathrm{E}[\varepsilon_{it}|\mathbf{x}_{i1}, \mathbf{x}_{i2}, \cdots] = 0$, where the current disturbance is uncorrelated with the independent variables in every period (either past, present or future). However, the core of the panel data analysis is concerning heterogeneity. Assumption of the model implying heterogeneity is the part of mean independence property, defined as: $\mathrm{E}[c_i|\mathbf{x}_{i1}, \mathbf{x}_{i2}, \ldots] = \alpha$. The last important assumption is related to the random effects model, where if the missing variables are not in correlation with included variables, they may be included in the disturbance of the model. It is quite a strong assumption. These four properties represent a generalized overview of the panel data modelling. Each of four different panel date models has its own additional features and extensions; yet, these four properties are intersection points for all models. The models are divided into pooled regression, fixed effects, random effects and random parameters type of models. Each of these models have many different sub-categories and adjustments.

The panel data event study modelling is based on the fixed effects panel data models. Greene (2012) argues that if $\mathbf{z}_i$ is unobserved, but correlated with $\mathbf{x}_{it}$, the least squares estimator of β is biased and inconsistent, as a consequence of an omitted variable. In such case, the fixed effects model approaches to the term α_i by taking it to be a group-specific constant term in the regression model. It is important to underline that the term "fixed" refers to correlation among c_i and x_{it}. It does not mean that c_i is nonstochastic. The fixed effects model arises from the assumption that the omitted effects, c_i, in the general model (17) are correlated with the included variables. This can be represented by $\mathrm{E}[c_i|\mathbf{X}_i] = \mathrm{h}(\mathbf{X}_i)$. Since the conditional mean is the same in every period, the model can we written in the following form:

$$y_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + \mathrm{h}(\mathbf{X}_i) + \varepsilon_{it} + [c_i - \mathrm{h}(\mathbf{X}_i)] \qquad (31)$$

$$y_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + \alpha_i \quad + \varepsilon_{it} + [c_i - \mathrm{h}(\mathbf{X}_i)] \qquad (32).$$

By model assumption, the last term is uncorrelated with $\mathbf{X}_i$, so it can be absorbed under the disturbance term, and more generalized form of the fixed effects model can be written as:

$$y_{it} = \mathbf{x}_{it}'\boldsymbol{\beta} + \alpha_i + \varepsilon_{it} \qquad (33).$$

4.3.1.2 Panel event studies estimation and inference

The longitudinal data analysis is considered one of the most active and innovative parts in econometrics literature, mostly because panel data provide a rich environment in segment of development of estimation techniques and theoretical results (Greene, 2012). The estimation modelling, as defined in Clarke and Schythe (2020), starts with considering a panel which covers a group indexed as g and time periods t. A variable recording the time period t in which the event is adopted in group g is denoted as Event_g. The outcome of interest is marked as y_{gt}. Panel data model is then defined by the following mathematical expression form:

$$y_{gt} = \alpha + \sum_{j=2}^{J} \beta_j \left(\text{Lead}_j\right)_{gt} + \sum_{k=1}^{K} \gamma_k (\text{Lag}\, k)_{gt} + \mu_g + \lambda_t + X'_{gt}\Gamma + \varepsilon_{gt} \qquad (34).$$

From the expression, indices μ_g and λ_t are group and time fixed effects, respectively. Further, X_{gt} are time-varying controls, optionally, and ε_{gt} is an observed error term. Lead and lag term in statistical analyses defines an estimation of a leading variable in cross-correlation with the values of a lagging variable in the time series. Leads and lags terms relative to the event of interest within the event study methodology are defined in the following way:

$$(\text{Lead J})_{gt} = \left[t \leq \text{Event}_g - J\right] \qquad (35)$$

$$(\text{Lead j})_{gt} = \left[t = \text{Event}_g - j\right] \quad \text{for } j \in \{1, \dots, J-1\} \qquad (36)$$

$$(\text{Lag k})_{gt} = \left[t = \text{Event}_g + k\right] \quad \text{for } k \in \{1, \dots, K-1\} \qquad (37)$$

$$(\text{Lag K})_{gt} = \left[t \geq \text{Event}_g + K\right] \qquad (38).$$

Leads and lags terms are, moreover, in these expressions the binary variables. They indicate that the given group was a given number of periods away from the event of interest in the respective time period. A single lead or lag variable is omitted to capture the main difference among groups where the event does or does not occur. Groups in which event never occurs are used as a baseline and act as pure controls. These sets of units have all zeros in all lead and lag terms. Thus, lead and lag terms only represent the difference between the treated and the control groups. Further, the panel data analysis includes the "post-event" single indicator, for all periods after the event occurrence in the treated groups. Outcome of interest is defined:

$$y_{gt} = \alpha + \beta \text{PostEvent}_{gt} + \mu_g + \lambda_t + X'_{gt}\Gamma + \varepsilon_{gt} \qquad (39)$$

where $\text{PostEvent}_{gt} = [t \geq \text{Event}_g]$. The inference goal is to examine potential serial correlation in the outcome variable over time. It is very important to account for the within-cluster level of correlation, which is mainly resolved using a standard solution of cluster-robust variance-

covariance estimator (CRVE). It is used in order to estimate standard errors and confidence intervals on regression parameters. In closing, however, it is important to highlight that the panel data event study methodology developed from the two-way fixed effect regression. It is based on a difference-in-differences design, which represents a staggered adoption design form where units are treated at different times (t_0,t_1,…), and there may or may not be never-treated units (Abraham & Sun, 2021). Serial correlation of difference-in-differences forms can overestimate t-statistics, as its main flaw, but should be dealt with (Bertrand, Duflo & Mullainathan, 2004).

5 ANALYSES AND RESULTS

The aim of this thesis is to empirically analyse the effect of key interest rate hikes, announced by the Federal Reserve System and the European Central Bank in 2022, on the stock market performance of the US and the eurozone, as the response to raging inflation using the event study methodological approach. The year 2022 was already entered with unstable inflation rate variations and sufficiently destabilized inflation rate target, as the post-Covid result. As the Russia-Ukraine war conflict started, at the end of February 2022, the repercussions of even higher inflationary environment evolved. Inflation rates, globally, hit extremely high rates during 2022, especially in March and April. The European Union was the one most hit by the war consequences. The US inflation rate followed. Commodity market prices of both economies exhibited large volatility rates, and stock market prices reacted as well. As the institutions that keep and take care of the price stability, central banks had to intervene. Both, the FED and the ECB, decided to start increasing their monetary aggregates in order to push the inflation down. The FED was the first to make such a decision, and other central banks followed. After the FED, the Bank of England started with same measures, and then the ECB followed as well. Measures were to be implemented in continuous time periods all through 2022, with an aim of continuation in 2023. Focus was on slow increase of the key interest rates and on slow adjustment process, which will directly impact inflation rates and push them downwards. There is an unavoidable correlation of the inflation rate and stock markets price movement. Monetary policy adjustments affect stock markets' performance, and this thesis investigates how much of a shock these announcements left on the stock market prices and investors' expectations. The thesis looks deeper into effect of the event on stock prices.

As already pointed out, the central banks' announcements are partially exogenous variables, since the stock market participants were in expectation of their reaction. However, they did not know when the measure adjustments would start and how strong they would be. The anticipation was present and is probably observed in stock price movements. Yet, as it is inevitable that such announcements did leave a trace of change, this empirical analysis does account for investors' anticipation behaviour. The model is based on daily prices and daily return changes, where estimation and event windows are used to have a closer look into the point in time (daily determined) when the market participants' expectations started to mark

changes. This thesis considers both, estimation and event, windows as short horizons. This means that their deviations, prior to and posterior to the event, are determined in time points of days, from several days to several months. Short-term horizon event study analyses are much more reliable than long-term horizon analyses, which adds to research credibility. In other words, short-term horizon windows are much less affected by other external factors, where the conclusion can be more reliably extracted from the analysed variables and their related behaviour. The analysis is based on historical stock prices and historical other assets' prices. Prices are obtained as time-series data sets and the same events in previous time points are used for comparison reasons. The time series in this analysis is set from 1998 until 2023. The main market scopes of this thesis are the US market, and the European Union market, with a focus on eurozone. The thesis is further spread to emerging markets as an important indicator of global stock market performance due to the 2022 crisis. It is especially important to compare eurozone countries with the European emerging market economies, as they exhibit a large degree of dependence on each other. This is implicit in Eastern Europe. The European Union and other European countries took the biggest stake out of the 2022 crisis; however, the global scene followed and inflation rate volatility did not avoid anyone. The scarcity of energy resources was the initiating shock, transmitting market panic further on.

5.1 The European and the US stock markets

The European stock market is represented by the Europe STOXX 600 index, whereas the US stock market is represented by the S&P 500 index. Databases are collected and obtained from the Bloomberg Terminal software, on the basis of daily prices, where the US stock data are in US dollars and the European stock price levels are determined in euros. All database analyses are rendered through the R statistical programming tool. Namely, the thesis is based on the event study methodology, i.e., the core is to analyse the impact of the key interest rate hikes of the ECB and the FED on the European and the US stock market performances. As the fundamental idea of the thesis is based on the overall stock market performance of these two economies, this research thesis focuses on the industry-level analyses of two mentioned indices. This means that the main congruent for each stock market event study analysis are their respective industries, and not firms per se. The European index consists of 600 firms and the US index consists of 503 constituents. The Europe STOXX 600 is divided into sixteen industries, and each of these industries is part of the event study database. This index is composed of the following industries: real estate (industry index ticker is SX86P), automobiles and parts (SXAP), banking industry (SX7P), basic resources (SXPP), chemicals (SX4P), food and beverage (SX3P), construction and material (SXOP), health care (SXDP), industrial goods and services (SXNP), insurance (SXIP), oil and gas (SXEP), retail (SXRP), technology (SX8P), telecommunications (SXKP), travel and leisure (SXTP), utilities (SX6P). The S&P 500 index, on the other hand, is divided into eleven industries. Those industries are: consumer staples sector (S5CONS), energy sector (S5ENRS), utilities sector (S5UTIL), health care (S5HLTH), industrials (S5INDU), materials (S5MATR), financials

(S5FINL), real estate (S5RLST), info tech (S5INFT), communication services (S5TELS), and consumer discretionary sector (S5COND). Each industry sector prices are daily levelled. Furthermore, each industry returns have to be daily levelled in order to get as precise event study analysis as possible. For this reason, data are collected on the basis of daily frequency. Returns are further calculated using R, the normal, as well as the abnormal returns. This research thesis bases the normalization of returns on the market model. As benchmarks, the S&P 500 and the Europe STOXX 600 are used for the US and the European markets, respectively. This means that the normalization of industry returns is based on the overall broad market index, on whose basis R_{mt} is calculated. The European and the US stock market index databases are collected from the beginning of 1999 until the beginning of 2023.

5.2 Impact of interest rate hikes on stock market performance

Stock market performance is sensitive to any new information circulating in the financial system and directly affecting stock prices. One such information set is a change of the key interest rates by central banks. No market is completely efficient in reality, such a case is with stock markets as well. Trading assumes taking advantage of the position, information, and the right opportunities for the investor's own financial benefit. Informationally, efficient markets assume unpredictable prices, which is a condition highly satisfied. However, it is hard to assume that all prices reflect all available information sets and that all participants hold the same information without utilizing any additional economic benefit based on these or any other additional sets of information. Yet, it is important to have a perfect market theoretical fundament, in order to analyse more realistic deviations and phenomena. The event study methodology is based on the assumption of information shocks. Any unexpected information form that affects all participants, without any information leakage, is to be tested against participants' realized returns. Theoretically, it is expected that information shocks are momentarily observed in prices and returns. Event study analysis calls upon exogenous or partially exogenous events. This means that events affecting returns are unexpected or semi-unexpected. Such condition tends to provide more precise results since market expectations are not aligned with new information and do not incorporate the same. Exception from the rule occurs in cases when the event is triggered by the change in the market value of an asset. In this case, one can talk about endogenous events. However, it is important to point out that this thesis focuses on semi-exogenous events. Since the year 2022 was the year of raging inflation, it was partially expected by investors that central banks would intervene in order to stabilize overall price levels. The unknown factor was based on the type of central bank reactions and form of new strategies, together with the timing of the same. The first change was the most unexpected possible event change, where all the subsequent changes were already announced to take place and each subsequent change was more and more incorporated within the investors' set of expectations. By the end of 2022, it could have already been anticipated how long interest rate hikes could last and it could be likely to forecast by how much they could have been increased. Yet, the first shock was the highest and it is interesting to see how investors could have anticipated that the monetary

policy creators would seem to behave by using the system of estimation and event window manipulation. It is interesting to see that the change in central banking behaviour was, in a certain way, unexpected, since decades have passed from such intense interest rate increase. One can argue that investors have been for a long time in the environment of low interest rates, accommodating their positions to the same and they were fairly used to such a form of environment. It is inevitable that monetary policy creators did add to stock market panic and price changes, mainly due to the intense and frequent interest rate hikes. The path they chose in order to push inflation backward could, potentially, be one of the reasons for caused stock market disturbances. For all these reasons, I find this thesis important and relevant. The stock market analysis is divided into two sections, the European and the US stock market analysis.

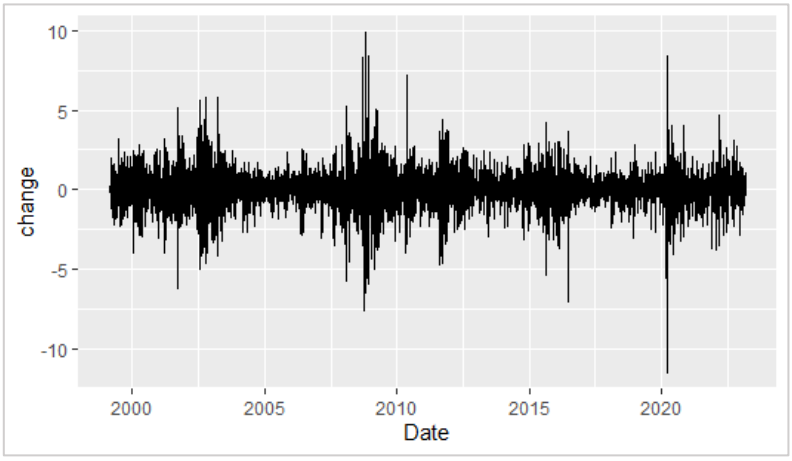
5.2.1 Impact on the European stock market

The main representative of the European stock market, in this research thesis, is the index Europe STOXX 600. This stock index is constituted of sixteen industry sectors. The main market model benchmark is an overall index performance. The European Central Bank is the main central bank of the countries that have adopted the euro as their common currency. The index STOXX 600 is the broader index that includes companies of a broader scope than just the eurozone companies. Therefore, it provides a more concise outlook of the overall European stock market performance. It is inevitable that all the countries within the EU which have not yet adopted the euro and other non-EU countries are under direct impact of the euro stability and the ECB measures. Their main trading partners are eurozone countries, and the positive performance of eurozone companies, their positive economic indicators, and their stable euro currency are of the main interest of all other European economies. They depend on each other. The European stock market indices have seen many disturbances during the 2022 raging inflation period, and are still observed. Nothing different is the STOXX 600. The event study methodology started with return calculation. Since the databases are collected in terms of prices on the daily frequency, returns are calculated in terms of daily frequency as well, for the period from 1998 until 2023. The main database for the European market, after the return calculation, consists of 17 entry columns and 6,162 entry rows. Stock markets exhibit high volatility of returns and the volatility of the Europe STOXX 600 stock index is presented in the following Figure 6. Volatility, as the main feature of stock prices, has a higher density pattern as the time-frequency decreases.

The stock market volatility for this index exhibits tremendous movements on a daily basis. It is observed that the largest return deviations were seen during the 2008 crisis and the mid-Covid crisis at the beginning of 2020. The period of 2022 exhibits market changes, yet not as turbulent as during 2008. Appendix 2 shows the daily returns of four individual industries, the banking industry, food and beverage, oil and gas and health care industry sectors. These four industries represent the four most affected industries. The health care industry was mostly affected during the COVID-19 crisis, especially at the beginning of 2020, when it exhibited the lowest negative returns. The banking sector, oil and gas sector, and mostly food

and beverage sector show larger volatility lags during the 2022 raging inflation crisis. For the purpose of this analysis, the impact of the key ECB interest rates on the stock market performance is set to main refinancing operations rates. Two other rates are not taken into consideration, due to the very nature of these rates. The main refinancing operations rate is the one that mostly affects stock prices and is comparable to the federal funds rates.

Figure 6: Europe STOXX 600 index, daily returns, 1999-2023



Source: Own work.

5.2.1.1 Event study analysis of the European markets with varying windows

After creating the STOXX 600 industry data set, and determining impacting key interest rate variable, each industry had to be assigned to each event date from the Table 1, hence creating a new database for the event impact testing procedure in R. Statistical software R uses the package "eventstudy" in order to run the event study analysis. As pointed out, the market model is specifically used in order to normalize the data returns. One of the highly beneficial advantages of the event study methodology is based on event window manipulation. This means that by enlarging and reducing event time lags from the mean event time, this analysis offers a more precise look into abnormal return behaviour as the event takes place. The event window is specified in days from the event time and returns are based on the daily level. The R specifies the unique code in order to run the event study analysis. Using the event study R package, see Shah and Jain (2020), the adjusted code for the analysis of this thesis includes variable of firm returns, event list, event window, inference, and return models presented as:

```
es_EU ← eventstudy(firm.returns = ts_STOXX600_Industry,
                   event.list = ECB_rates_final,
                   event.window = 5,
                   type = "marketModel",
                   to.remap = TRUE,
                   remap = "cumsum",
                   inference = TRUE,
                   inference.strategy = "bootstrap",
                   model.args = list(market.returns = ts_STOXX600))
```

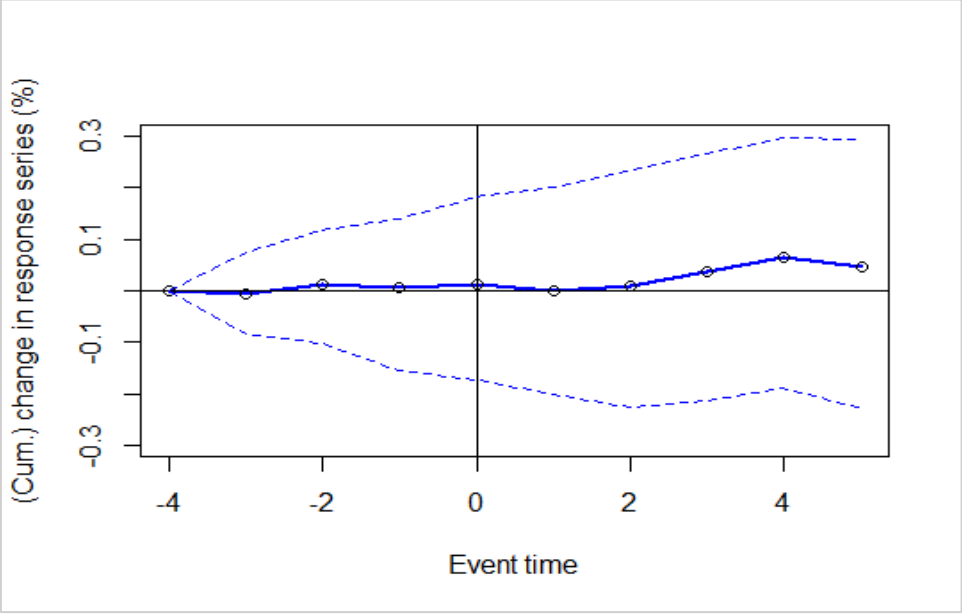
(40).

This form of event study market model argumentation runs the analysis both across time and cross-sectionally across different industry sectors. Check the sub-sections 4.2 and 4.3 of this thesis for the market model regression explanation. Due to the nature of the database used under the firm.returns argument, the regression can be explained by the formula (41), where:

$$\tilde{R}_{it} = \alpha_i + \beta_i \tilde{R}_{mt} + \sum_{a=1}^{A} \gamma_{ia} D_{at} + \tilde{u}_{it} \qquad (41).$$

Code arguments under the change throughout the analysis are firm.returns, event.list, then event.window lags and model.args. They change depending on the analysis of either the US or the European market, where the appropriate databases for each respective market are used. Also, the appropriate key interest rates are used depending on the analysed market. On the other hand, event.window argument is changed depending on the time gaps used to test the implicit market event impact. It is based on the daily frequency. For example, the above code sets event.window to 5, which means that the left and right deviation from the mean event time is 5 days prior to and after the event date. Event window manipulation changes event lags. The event window of 5 days prior and posterior to the mean event time for the European stock market exhibits an increase in the cumulative daily ARs for the given window lag.

Figure 7: Event study analysis I (event window = 5 days), European stock market



Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

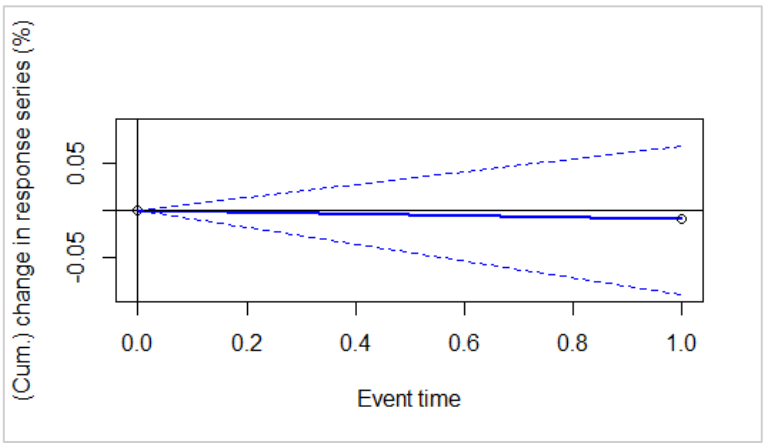
Figure 7 shows that the cumulative abnormal returns deviate slightly above 0% for the almost whole event window spread, especially after the second day after the event date. By observing Figure 7, the highest impact on the stock price movement is observed during the fourth day after the event. The period before the cumulative event date does not exhibit a significant impact on the stock price movement, although it exists to a slight degree. Further analysis exhibits abnormal return deviations and different trend patterns under event window

lag changes. This analysis, Figure 8 and Figure 9, outlines cumulative abnormal return patterns under the event window of 1 day, 10 days, 15 days, 30, and 60 days. The event window lags are all determined as short-horizon lags since the time span of up to one-year lag deviations from the event mean are considered to be short-termed. This analysis requires the short-term horizon event window manipulation, due to the very nature of the event.

Key interest rates, set to act upon inflation rates and price stability are usually short- to mid-term measures changed when the price stability is reached. Hence the short-term event window spread. If one closely observes Figure 9, it is evident that greater shock to the stock market is exhibited when the event window lags are enlarged. This confirms the argumentation of the interest rate changes being semi-exogenous events. By enlarging the window lag from 5 days to 10 days, a larger deviation from the mean is exhibited, and the impact is observed within the negative area.

Actual returns in a 10-day event window setting are lower than expected for the whole event window spread. Enlarging further to the 15-day window spread, the abnormal return curve starts to get closer to zero at the extreme points, whereas the mid-curve pattern is still largely negative, to the same degree as is in the 10-day window spread. The event window lag of 30 days starts to exhibit a higher degree of volatility, whereas the highest degree of volatility is observed within the event window lag of 60 days, though.

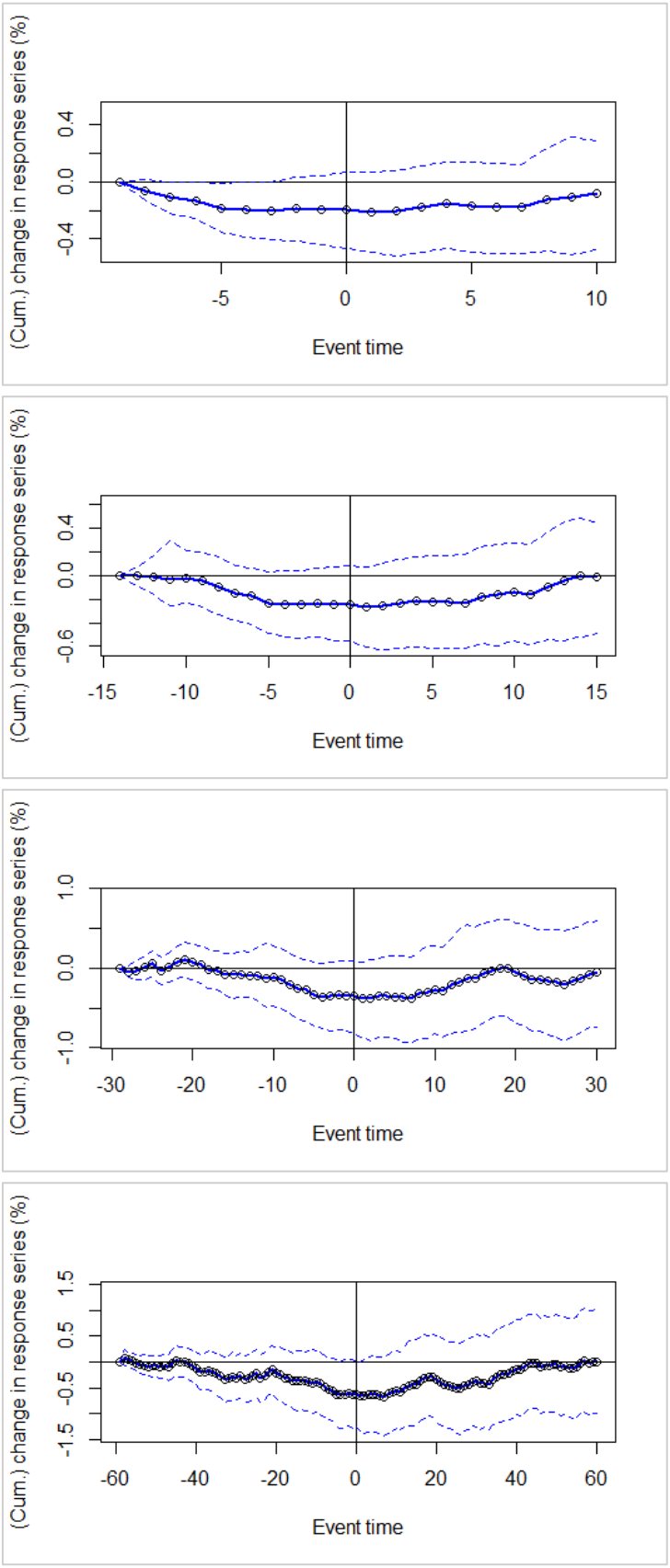
Figure 8: Event study analysis II (event window = 1 day), Europe



Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Figure 9: Event study analysis III (event window = 10,15,30 and 60 days), Europe



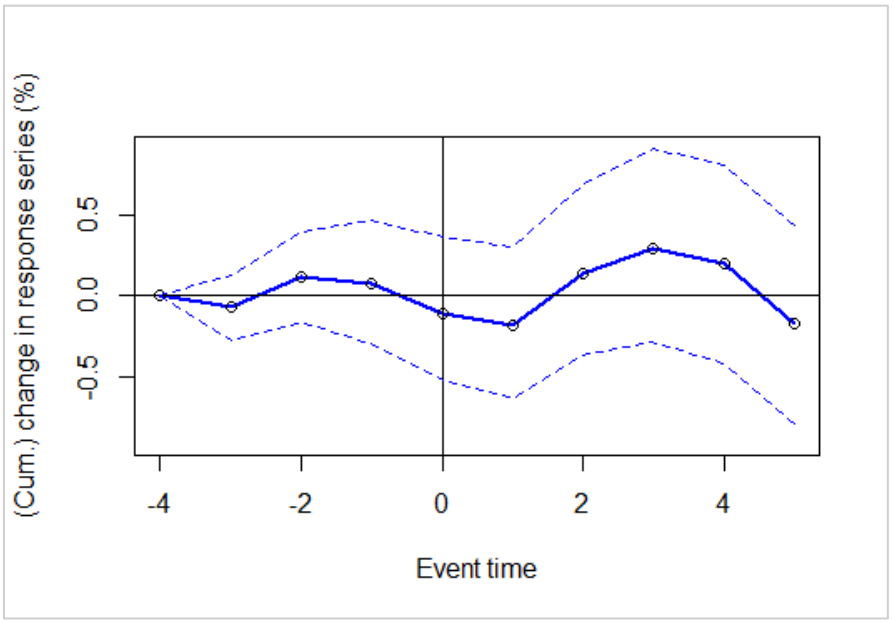
Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

This volatility can be explained by market uncertainty to when the central bank (in this case the European Central Bank) will act upon key interest rates. As days decrease, the abnormal return curve tends to exhibit more and more linear patterns closing towards the expected returns. If we look at the 1-day event window lag, the curve is almost completely linear and aligned with the expected returns. Another interesting point is that the 1-day lag shows a slight negative abnormal return impact prior and posterior event date, mostly after the event date. All other event window lags also exhibit negative impacts; yet, the 5-day event window lag exhibits positive cumulative average abnormal returns. This likely tends to show a partial market adjustment, since the FED is, usually, the first one to react to negative interest rates. There is a high possibility that the market had expectations of a similar reaction of the ECB. The outlook of Figures 7, 8, and 9 is based on all sixteen Europe STOXX 600 industries. Further analysis is based on the sampling of up to three industries in order to observe their sampled behaviour. The sampling aims to test the most affected industries during the year 2022 and the financial industry sector. The financial industry sector is highly sensitive to interest rate changes. For the first industry sample, I chose sectors of oil and gas, food and beverage, and basic resources. Due to the lack of supplied oil and gas, the European market has suffered the most. The next largest inflationary pressure was observed in basic foods and agricultural goods, due to war consequences. The basic consumer resources soon exhibited large price increases as inflation raged further on. Figure 10 exhibits a 5-day event window lag for these three industries. The cumulative average abnormal returns exhibit a far more volatile pattern in comparison to the whole industry (compare Figure 10 to Figure 7). Even though the curve pattern exhibits a volatile trend, the abnormal return curve strikes both positive and negative areas for the whole event window spread. Appendix 3 presents these three industries under the event window lag changes. The event window lag of 10 days exhibits larger abnormal return deviations, from -2 to 0, compared to the whole industry 10-day window, where the varying range of abnormal returns is from -0.4 to +0.4. Event windows of 15, 30, and 60 days for this sample exhibit far wider abnormal return deviation spreads than for the whole database. Larger the event window, larger the spreads in this case.

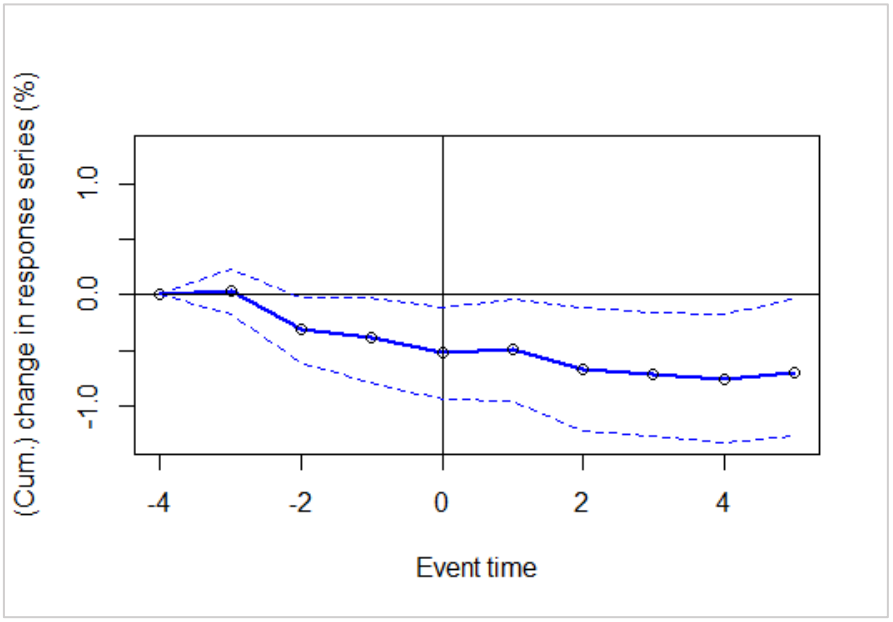
The second sample is presented in Figure 11. It is never possible that any crisis will not have an impact on financial corporations and the real estate sector. By testing the second sample which consists of the banking sector, the insurance sector, and the real estate sector, the high impact of the event is exhibited. The cumulative average abnormal returns for this sample, under the benchmark of five days prior to and posterior to the event mean, tend to exhibit a falling negative pattern. The negative impact is greater after the event mean in comparison to the period before the event mean. The abnormal return curve is constantly decreasing, with an overall spread between 0% and -0.85%. There is a slight stagnation observed around the event mean amounting to -0.5%. The minimum value of the spread is reached on the 4th day after the event.

Figure 10: Event study analysis IV (event window = 5 days), first sample, Europe



Source: Own work.
Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.
Note 2: Sample includes three industries: oil and gas sector, food and beverage and basic resources sectors.

Figure 11: Event study analysis V (event window = 5 days), second sample, Europe

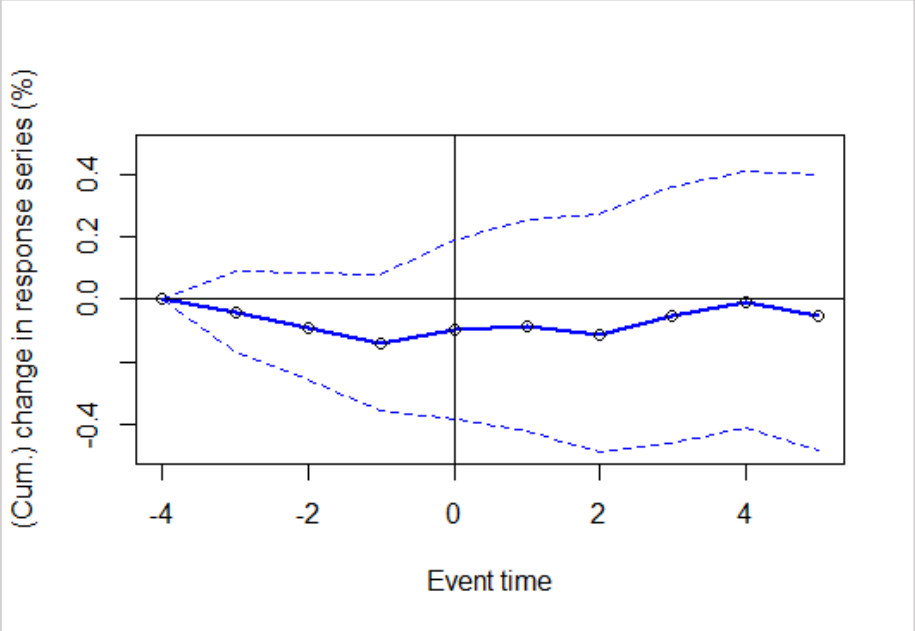


Source: Own work.
Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.
Note 2: Sample includes three industries: banking sector, insurance sector and real estate sector.

The next segment of the analysis exhibits abnormal return behaviour under the division of interest rate movements. Here, I divide interest rate movements under the increasing and decreasing rate conditions. The MRO rate database is segmented under these two conditions, and the CAAR behaviour is tested under increasing and decreasing conditions. The next two

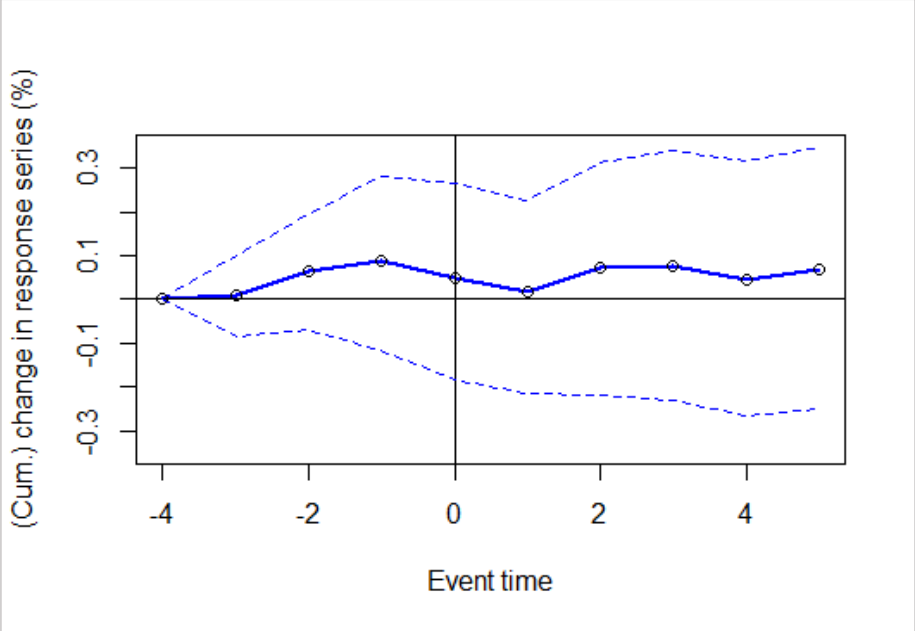
figures, Figures 12 and 13, exhibit negative low abnormal return behaviour when key interest rates are decreasing, and positive, i.e., higher than expected, behaviour when key interest rates are increasing, respectively. Both figures exhibit return behaviour under the five days, "benchmark", event window lag. In Figures 12 and 13 the whole industry sample is included.

Figure 12: Event study analysis VI (event window = 5), decreasing rates, Europe



Source: Own work.
Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Figure 13: Event study analysis VII (event window = 5), increasing rates, Europe

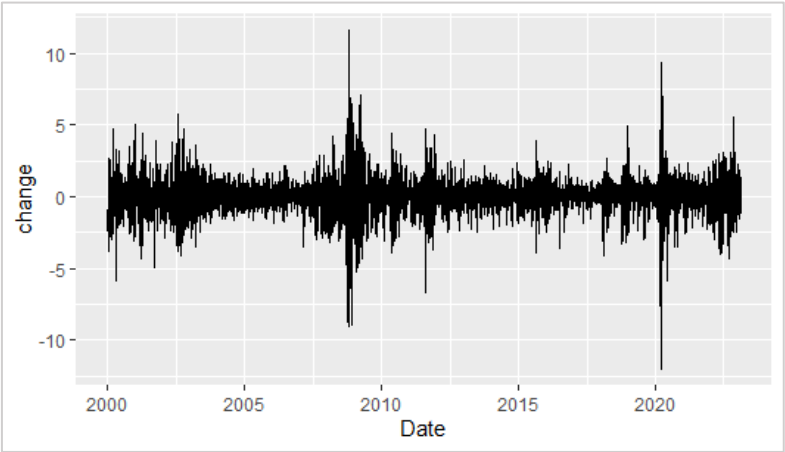


Source: Own work.
Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

5.2.2 Impact on the US stock market

Index S&P 500 is the main representative of the United States stock market in this research thesis. It consists of 503 listed companies and eleven industry sectors (Bloomberg, 2023). The overall market index is used as the benchmark for the market model. Time series are the same as for the European market. The time span is defined from the beginning of 1999 until the beginning of 2023. All stock index industry prices are collected on a daily frequency and are determined in US dollars, whereas the European stock index prices are collected in euros. The federal funds rate is the rate by which the US central bank, the Federal Reserve System, acts upon inflation rates and aims their goal of price stabilization. By manipulating the federal funds rate, the FED directly influences the inflation rate and other interest rates within the financial system. As it is observable from Table 1, the federal funds rate, from the 16th December 2008, has been set to the range level. For example, on this date, it was set to a level ranging between 0.00 and 0.25 percent. This range level has been in practice by the FED ever since. For the purposes of the thesis, I have used the upper limit of the range for the analysis. This means that in the case of 16th December 2008, for example, I have used the value of 0.25%. The same approach is valid for each subsequent event date. Each event, in the event study methodology, has to be uniquely defined by the date and value. This means that the testing procedure recognizes only one unique value for each event date specified. The main reason why the upper limit was chosen is based on my decision to test for the extreme tails rather than the average value. Since each subsequent interest rate decision change continues from the upper tail limit or falls back up to the lower limit tail, I believe that the decision on testing for the upper limit tails, as the extreme points, is more beneficial for the proper testing procedure and more adequate for the nature of this analysis. The testing for the impact of federal funds rate changes on the US stock market is no different than the previous analysis, where the first step starts from the stock return calculation. The databases have the same origin as the European stock market index databases. The first and the main database for the US stock market event study analysis consists of 12 entry columns and 5,814 entry rows. Figure 14, represents the overall index daily returns, 1999-2023.

Figure 14: S&P 500 index, daily returns, 1999-2023



Source: Own work.

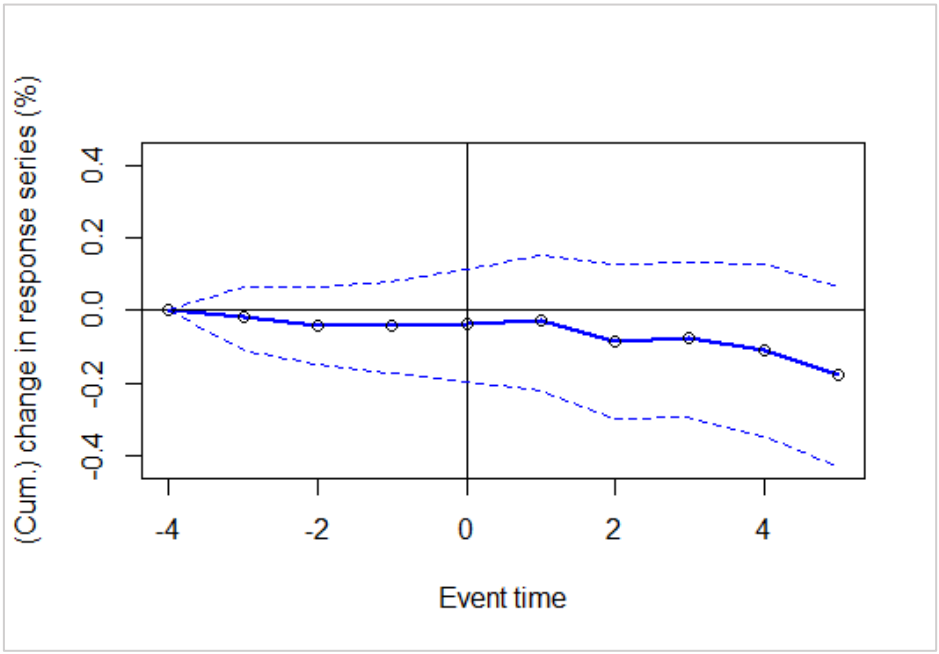
Compared to the European index returns, S&P 500 index exhibits stock return volatility in the same limits, hence from -10% to +10%. Although, S&P 500 returns have exhibited a bit larger spread volatility during the 2008 crisis, slightly above +10%. Both economies are developed economies, and crises affect both in a fairly similar way. The US stock index returns were mostly affected by the 2008 crisis, COVID-19 crisis and the last 2022 crisis. It is, though, quite important to point out that the random walk of S&P 500 and Europe STOXX 600 differs in the density of the random walk representation. This means that the tails of the US stock index volatility are smaller at the points of low volatility than is the case with the European index. Both tend to follow fairly similar response to crises, due to high degree of dependency among each other. Yet, the S&P 500 stock index returns exhibit fairly calmer reaction during economic expansion periods in comparison to the Europe STOXX 600. Such a difference can be definitely based on the fact that the STOXX 600 index is a broader index encompassing some of the non-eurozone countries. Stock return movement, in theory, is explained by the random walk theory, which states that each stock price change is random and that historical prices cannot be used to predict the future stock price movement. Fama, 1995, points out that the efficient markets or, at least, the semi-strong efficient markets are characterized by random walk and represent independency of each successive price change of individual security, thus any series of stock price changes has no memory whatsoever. In Appendix 4, stock returns are presented for the four individual industries, namely health care industry, financial industry, energy industry and consumer staples industry sectors. The most volatile industry among the four is the financial industry, which exhibited the greatest degree of volatility during the 2008 crisis. Although all industries, in their own individual degree, exhibit high shocks during the 2008 crisis, the health care industry exhibits the greatest, and importantly to highlight, negative volatility patterns during the COVID-19 crisis. Energy sector and consumer staples sector (which includes mostly basic consumer necessities, such are foods, hygiene and beverage products) exhibit not the largest, but highly dense changes in volatility from the year 2022. This observation correlates with the fact that these are the first and the most affected industries in the 2022 crisis, as a consequence of scarcity of energy resources, high oil and gas prices, and increased demand for agricultural products.

5.2.2.1 Event study analysis of the US market with varying event windows

Figure 15 exhibits the event study analysis of the federal funds change impact on the US stock market performance, under the event window of five days prior and posterior to event mean. If one compares Figure 15 with Figure 7, which presents the same analysis for the European stock market index under the same setting, crucial differences are observed. The movement of the abnormal returns for these two markets differ substantially. Namely, the abnormal returns for the US market exhibit a negative falling trend throughout the whole event window spread (check Figure 15). As the event window lag increases after the event mean, the more tense is the event shock on the stock prices. The margins of the CAAR movement are varying under the range of -0.2% and 0%. Five days event window lag is the "benchmark" margin window rate in this thesis, since the five-days lag is sufficiently close

short-period of time from the event date, where the investors could have already anticipated central banks' reaction to inflation rates and far enough from the event date for the proper methodological approach to the analysis. On the other side, if one observes Figure 7, CAAR curve exhibits positive return movement pattern within the margins of 0% to roughly 0.6%.

Figure 15: Event study analysis I (event window = 5 days), the US stock market



Source: Own work.
Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Figures 16 and 17 exhibit the event impact on the stock market performance under the event window lags of 1, 10, 15, 30, and 60 days prior and posterior to the event mean. One-day window lag, exhibited in Figure 16 and compared to Figure 8, exhibits a completely opposite movement pattern. While this setting causes abnormal European index returns to slightly fall into negative, throughout the event window spread, the US abnormal stock returns exhibit exactly the same movement but in the opposite direction. Yet, another important thing to point out is that as the event window gets larger, CAAR exhibits a decreasing trend and a more negative trend for the post-event period. Figure 17 exhibits greater volatility of CAAR with the enlargement of the event windows.

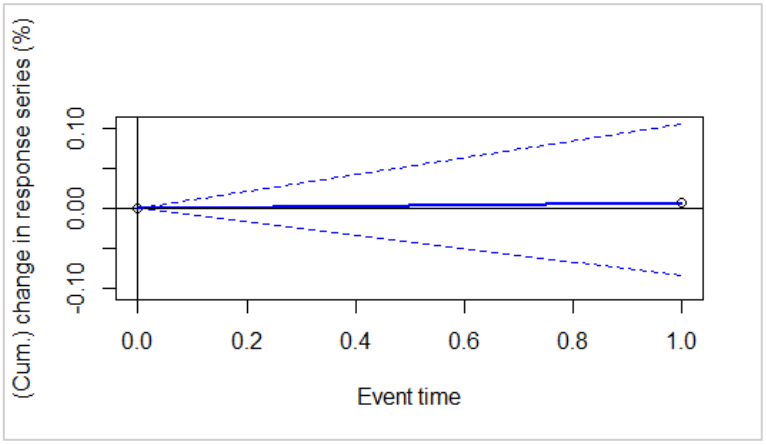
This is the case with the European stock index. However, as the European abnormal returns tend to stick with the zero values at the extreme end tails and enlarge in the mid-series under the window enlargement process, the US abnormal returns negatively decrease. Both stock markets exhibit more stretched abnormal return curve pattern when the event lags decrease.

The first sample for the US industry population is constructed based on the consumer staples sector, consumer discretionary sector, and energy sector. Figure 18 exhibits abnormal return behaviour under the event window of five-day lag. The first sample exhibits quite a negative

decreasing trend, which is the greatest during the post-event period, reaching roughly the value of -0.65% during the fifth day after the event. Appendix 5 of this thesis outlines the CAAR behaviour of the first sample under the event windows of 10, 15, 30, and 60 days. Unlike Appendix 3, where the first sample European abnormal returns fluctuate under three times larger margins, the US first sample abnormal returns fluctuate under the margins of negative 2 and +2. Both appendices, Appendix 3 and Appendix 5, are based on the sample group of similar industries and industries that were mostly affected by the 2022 ongoings.

By observing Figure 19, under the "benchmark" of the five-day event window setting, the second sample, which consists of financial sector, real estate sector, and industrials sector, differs substantially from the quite similar sample base of the European market. While the second sample of the European market exhibits a negative decreasing pattern movement throughout the whole event window spread, the US second sample varies from positive to negative abnormal return bound throughout the whole event window spread. The second sample of the European market is far more similar to the behavioural pattern of the first US market sample, ranging as well within the margin range of -1% and 0%, whereas the second US market sample is more similar to the first European sample abnormal returns' movement. One of the main differences of the US second sample in comparison to the European one, is that the US second sample consists of the financial sector, real estate sector, and industrials.

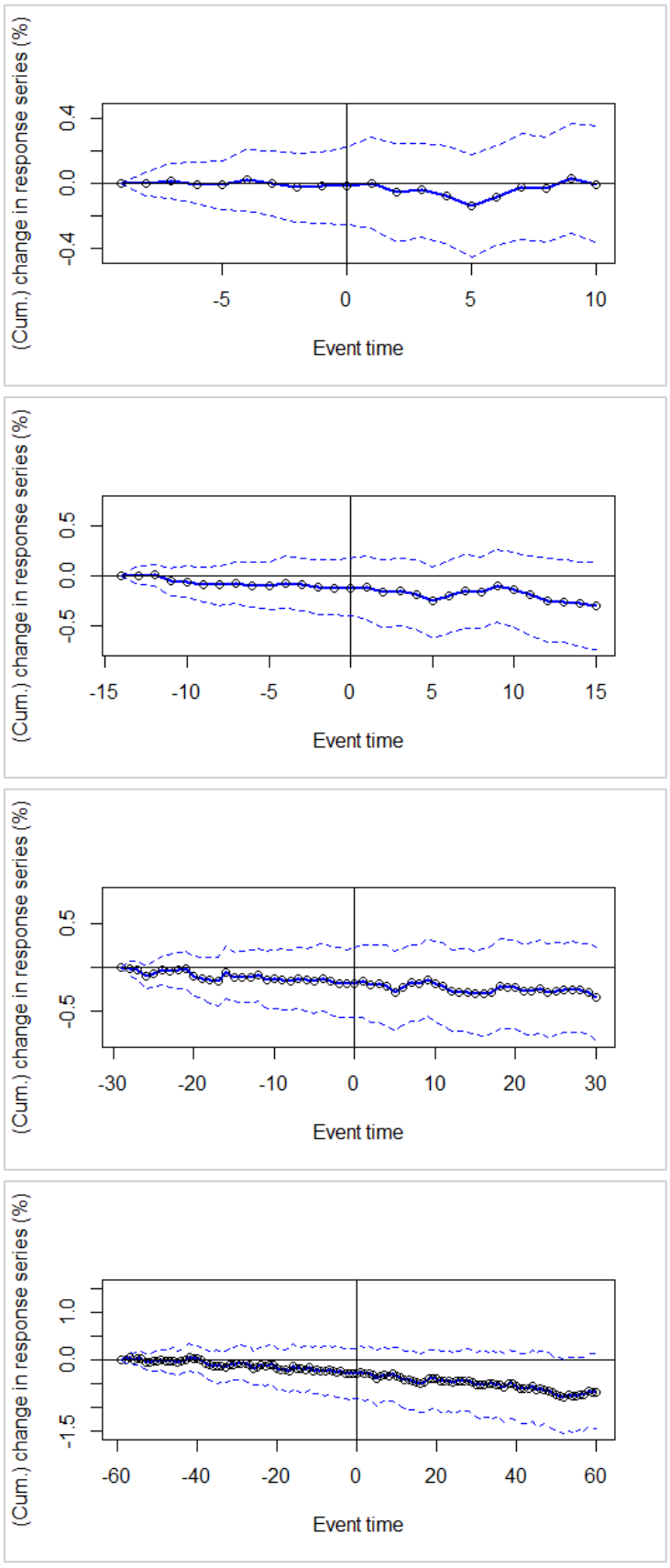
Figure 16: Event study analysis II (event window = 1 day), the US



Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

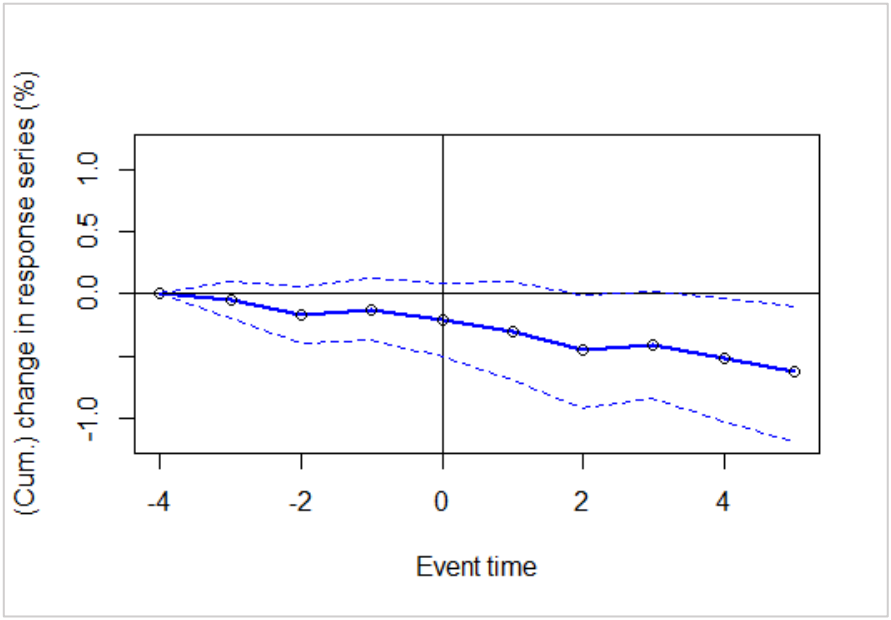
Figure 17: Event study analysis III (event window = 10,15,30 and 60 days), the US



Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Figure 18: Event study analysis IV (event window = 5 days), first sample, the US

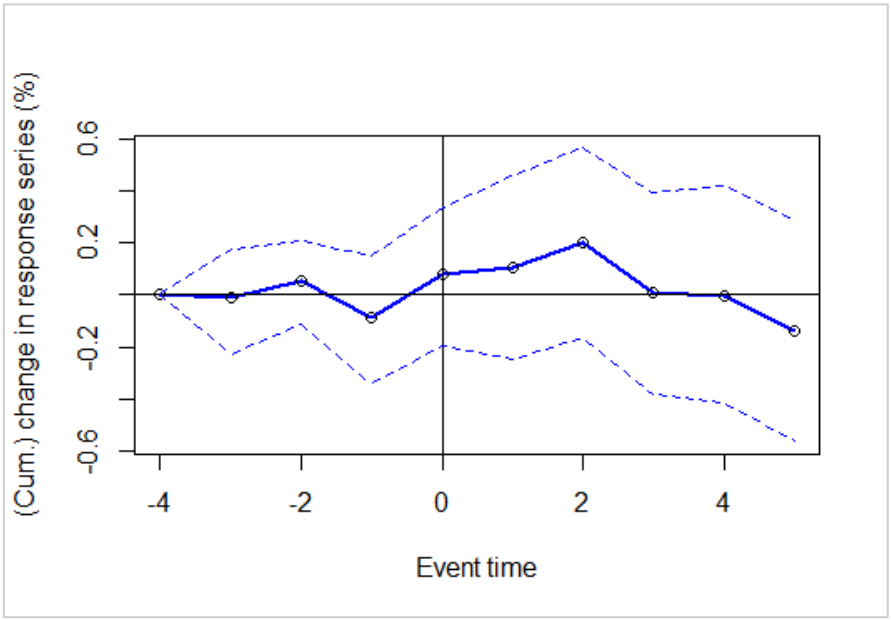


Source: Own work.

Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Note 2: Sample includes three industries: consumer staples, consumer discretionary and energy sectors.

Figure 19: Event study analysis V (event window = 5 days), second sample, the US



Source: Own work.

Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

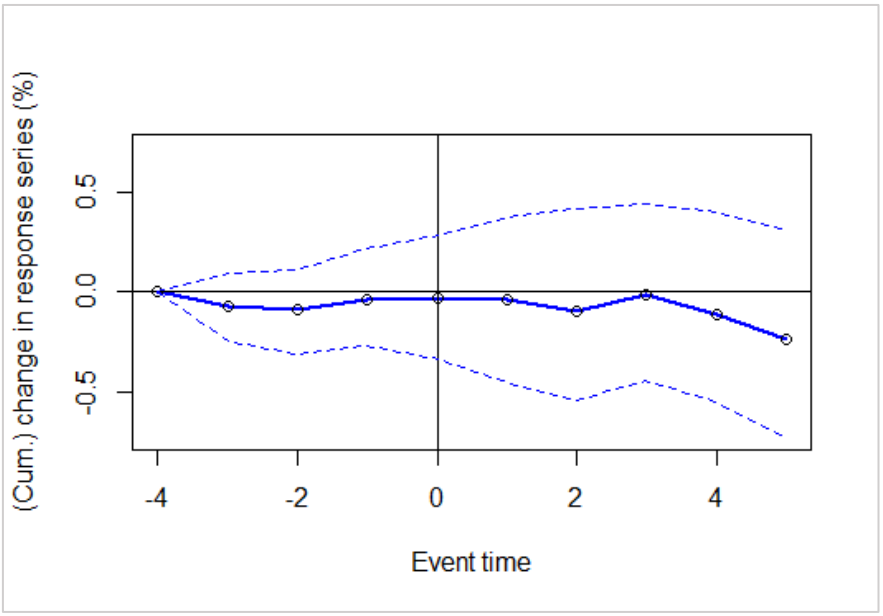
Note 2: Sample includes three industries: financial industry, real estate industry and industrials industry.

Industrials sector is not included in the European sample, but rather the insurance industry is included. The S&P 500 considers the insurance sector as part of financials industry. In the case of the US market, industrials sector adds upon more positive weight into the second sample. By excluding the industrials sector, the probability of more negative abnormal return

effect is expected to be greater. Event study methodology is more precise and concise as the number of impacted participants increases within the database. The R code for the event study analysis assumes for the inclusion of more than one participant, i.e., at least two impacted participants should be part of the analysed data set. I decided to apply the same setting for both by choosing three per each sample, since the financial sector for the European market is divided in two industries, namely the banking and the insurance industry sectors.

As the part of the last event study methodological analysis step for the United States market, I divide the federal funds rate changes into increasing ones and decreasing ones. I want to observe, here as well, how the stock market behaves under these two separate conditions. Figures 20 and 21 present these two settings. The most important phenomena here, which is different from the European market, is that both settings impact abnormal returns negatively.

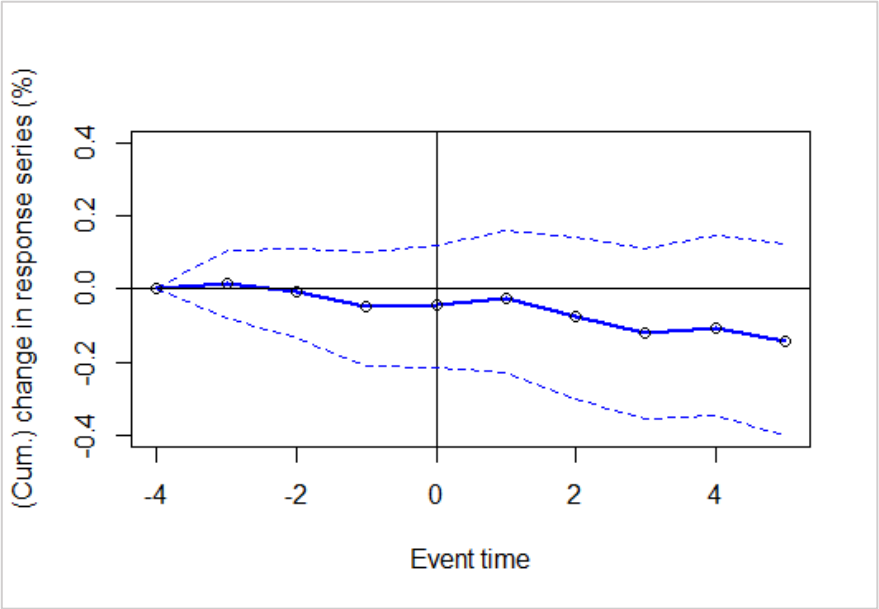
Figure 20: Event study analysis VI (event window = 5), decreasing rates, the US



Source: Own work.
Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

However, increasing interest rates tend to cause greater negative impact on the United States stock market performance in comparison with the decreasing interest rates. Both settings exhibit the greatest negative cumulative event impact during the post-event period. During the fifth post-event day both settings reach the same and the most negative value of abnormal returns amounting to roughly -0.2%. Around the mean event value, decreasing interest rates setting tends to have a value of CAAR closer to 0%, i.e., closer to the expected return value, than is the case with increasing interest rates setting. Despite volatility, both curves decline.

Figure 21: Event study analysis VII (event window = 5), increasing rates, the US



Source: Own work.

Note: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

5.3 Statistical significance

The main question to answer with the event study analysis is concerning the abnormal return deviation calculation from the mean value. In other words, it is important to test if abnormal returns are unusually large around the event date(s). Statistical significance of this type of the analysis is based on the parametric and non-parametric tests. Each of these tests carries its own type of hypothesis form. Each null hypothesis is set to specify that the expected value of a random variable equals zero. The alternative hypothesis is set to specify the opposite case, where the expected value of a random variable is not equal to zero. Rejecting the null hypothesis concludes that the event had an impact on the tested variable. The difference among parametric and non-parametric test hypotheses differentiates in the finite-parametric distributional form while modelling the data. The parametric analysis defines data as the sample from the population that is modelled using probability distribution with the fixed parameters. Non-parametric tests define distributional assumptions and do not assume finite-parametric distributional form. Hypotheses can differ in the tested expected value, whether the expected abnormal returns, average abnormal returns, cumulative abnormal returns, or cumulative average abnormal returns expected values are being tested. Choosing among these four expected values depends on the number of instances under the study analysis. One instance requires the usage of the abnormal returns and cumulative abnormal returns. When there are more instances tested, as is the case with this research thesis, all the quantities are averaged across instances, i.e., across different events. Such multiple data testing procedures require average abnormal returns and cumulative average abnormal returns. The two-sided t-test, as the parametric implication of the statistical significance for the event analysis, is

used in this thesis. The event window tests for the implicit effect of the key interest rate changes on the stock market performance by setting the same days-deviation prior and post the event date(s). The event study relies on the standard normal distributional form, N(0,1), whereas the abnormal returns based on t-test undergo t-distribution. The form of the t-test is based on testing if the sample mean is significantly greater than or less than the population mean. The t-test is formed based on the abnormal returns which are divided by the standard deviation of the same abnormal return value. The free varying number of variables, defined as the degrees of freedom, for the market model that is used in this thesis, is equal to the number of observations of each individually-tested sample. The benchmark models used for normalization of the returns, use the free parameters, usually defined with K, which do not break any pre-determined constraints. The degrees of freedom depend on the normalization model. In this case, abnormal returns undergo the t-distribution with k degrees of freedom. Such t-distribution differs from the standard normal in the fact that the normal distribution accounts for the population mean and the t-distribution does not have such an assumption. It is rather based on the degrees of freedom, which are related to the sample size. Data within this thesis are extent, defined by the extent time series and multiple event dates. This research thesis defines the tested hypothesis based on CAAR as:

H_0: $E(CAR_i) = 0$, standardized cumulative abnormal return across industries is 0;
H_A: $E(CAR_i) \neq 0$, standardized cumulative abnormal return across industries is not 0.

The null hypothesis states that there is no effect whatsoever on the stock industries and stock price performance by the event(s) observing the movement of cumulative average abnormal return variable condition, whereas rejecting the null implicates the existence of the impact of the event(s) on the stock performance for the two analysed markets, the European market and the United States stock markets. Further analyses include statistical significance t-tests. If one looks at the figures for the European market, Figures 7, 10, 11, 12, and 13, and if one looks at the figures for the US stock market, Figures 15, 18, 19, 20, and 21, all these figures are presented with the inclusion of the two-sided t-test, the significance level of each tail is 2.5%. Tails represent the left and right extremes of the distribution curve. The two-sided t-test, in the event study methodology, represents testing for the times prior to and posterior to the event date(s). The movement of abnormal returns is mean-valued and is presented by the bolded blue colour in the figures. Lighter blue dashed lines are left and right significance levels of 2.5%. This part of the research thesis looks deeper into data numerical results. Here, the hypothesis is stated, numerical results analysed and the hypothesis is either accepted or rejected under the different analysed conditions. It is, moreover, important to point out, once again, that the statistically significant impact of the key interest rate changes on the stock market performance is achieved if and only if the null hypothesis is rejected.

By accepting the null hypothesis, no statistically significant impact is observed. In order to reach this form of a conclusion, the p value is calculated. The t-test p value is compared with the critical value, obtained from the table for the two-sided t critical values, in order to either

confirm or reject the null. Analyses done in this research thesis are multivariate, based not solely on one event, but series of events. They are, additionally, based on the cumulative twenty-three years of historical time series stock market daily returns, and numerous stock market industries. Such defined data sets, i.e., multivariate data sets, are run under different event window settings. What was aimed for in this thesis, was to test and present different data behaviours by changing the input conditions. This way, event study testing procedure exhibited many interesting and (un)expected phenomena. Since this research thesis was highly influenced by my own high interest in monetary policy effects and stock markets in general, together with the geopolitical global strategies, the 2022 ongoings were quite inspiring to formulate my thesis in such a way, and the thesis, therefore, starts on the basis of reflecting onto the 2022 ongoings. Even though the inspiration came from the 2022 global developments, I firmly decided to organize my thesis more broadly and include the more extended time-series note in the analyses. The effect on the stock market performance during 2022 is evident from the graphical presentations; yet, the focus was more broadly oriented. Analyses are done equally for both, the European and the United States, stock markets.

As data sets are large in their dimensions, and undergo many variables, permutation options are numerous. It is, loosely said, impossible to analyse all of them. I tried to be as creative as possible. Since the base is supported by the 2022 high inflationary environment, I wanted to show the behaviour of the most critical industries within this particular year. These and financial industries are hereby presented. The most critical industries are presented under the five different event window settings. Yet, the financial industries are presented only under the five-day event window "benchmark" setting for the purposes of comparison and due to its high sensitivity to interest rate changes. The most important segment of the analysis, next to the whole industry stock market index analyses under the six different event window settings, is the section where I divide the time series of the key interest rate changes for both, the European and the US, markets under the two segments. One is considering only key interest rate increases, and the other one is considering only key interest rate decreases. In order to outline a concise conclusion for my thesis, in this section, I present the numerical and tabular overview of my own reached empirical results. Not only the results for the all-included industries, under different event windows and under segmented interest rate changes for both markets, are presented, but also sampled industry groups under the same constraint variations. All of the results are presented in tabular form, with statistical calculations and inferences about the null. Here, the hypothesis is either rejected or accepted.

5.3.1 Empirical results

The statistical techniques used for the abnormal return aggregation are one-sided and two-sided t-tests. The statistical significance analyses are divided into the ones for all-included industries and the ones for sampled industries, for both the US and the European market. Empirical data and results are presented in the form of tables, and are found in this section starting from Table 2, and in the appendix section starting from Appendix 6. It is important

to point out that the null hypothesis (stated in section 5.3) under the t-tests is rejected, if and only if the absolute value of the calculated t-test is greater than the critical value. Since the event study is a two-tailed methodological approach, I analysed both, the one-sided and the two-sided, t-statistics. For the significance level of 0.025, the confidence level is equal to 97.5%. This level of significance is observed in the one-tailed t-test. For the significance level of 0.05, the confidence level is equal to 95%. This level of significance is observed in a two-tailed t-test. As already stated, the market model approach for return normalization, which was used in the event study calculations, defines the level of freely varying number of variables to be equal to the number of observations of each given sample. The t-table for the one-tailed t-test defines the critical value, under the significance level of 0.025 and degrees of freedom equal to observation numbers, to be in the range of 1.984 (100 degrees of freedom), 1.962 (1000 df), and 1.960 (above 1000 df). On the other hand, the t-table for the two-tailed t-test defines the critical value, under the significance level of 0.05 and the level of degrees of freedom equal to the number of sample observations, to be also in the range of 1.984 (100 degrees of freedom), 1.962 (1000 df) and 1.960 (above 1000 df). Both critical values are the same, since the methods are the same, yet differ in the observation. The main difference is whether one observes only one tail of the t-test (either lower or upper t-test), or observes both tails together in the absolute sum. Therefore, if the absolute value of the t-test is greater than the critical values of 1.984, 1.962, and 1.960, the empirical result proves of statistically significant event impact on the tested variable(s).

It is, moreover, very important to point out that CAAR results within the tables are presented for the daily frequency of abnormal returns and graphs exhibit cumulative values. Therefore, by looking at the graphs, the majority of them tend to exhibit CAAR values as statistically insignificant, while tables exhibit the majority of CAAR results as statistically significant and impactfully different than zero.

All presented calculations are my own empirical work. It is important to point out that the z value in standard deviation calculations equals 1.96, which is the z value at the 97.5% confidence interval. While the t value is calculated as the mean divided by the quotient of the average standard deviation and squared root of the sample size, the standard deviation general formula is derived from the confidence interval formula, which is defined as $CI = \bar{x} \pm z\frac{s}{\sqrt{n}}$,where CI is confidence interval, x overlined is sample mean, z is confidence level value (here equal to 1.96), n is sample size, and s is sample standard deviation. The same approach is applied for lower-bound, upper-bound, and average standard deviation types of calculation. The sample size is defined as the number of observables for a given sample. It is defined here as a multiple of observables such are: industries, events, and event windows.

Table 2: Empirical results, two-tailed t-test, both markets (all industries/all events)

T-test (Europe - all industries/all events)			
days	CAAR	t value	abs value
5	0.047	1.208	1.208
4	0.058	1.463	1.463
3	0.047	1.452	1.452
2	0.014	0.444	0.444
1	0.012	0.370	0.370

T-test (US - all industries/all events)			
days	CAAR	t value	abs value
5	-0.177	-4.538	4.538
4	-0.127	-3.717	3.717
3	-0.120	-3.802	3.802
2	-0.125	-3.806	3.806
1	-0.067	-2.079	2.079

T-test (Europe - all industries/all events)			
days	CAAR	t value	abs value
10	-0.091	-2.354	2.354
9	-0.177	-6.519	6.519
8	-0.241	-8.677	8.677
7	-0.323	-11.291	11.291
6	-0.378	-12.712	12.712
5	-0.394	-12.850	12.850
4	-0.386	-12.457	12.457
3	-0.379	-11.765	11.765
2	-0.421	-13.051	13.051
1	-0.451	-14.237	14.237

T-test (US - all industries/all events)			
days	CAAR	t value	abs value
10	-0.010	-0.255	0.255
9	0.023	0.498	0.498
8	-0.017	-0.111	0.111
7	-0.031	-0.945	0.945
6	-0.089	-2.551	2.551
5	-0.116	-2.963	2.963
4	-0.072	-2.033	2.033
3	-0.062	-2.550	2.550
2	-0.074	-2.221	2.221
1	-0.021	-0.663	0.663

T-test (Europe - all industries/all events)			
days	CAAR	t value	abs value
15	0.009	0.226	0.226
14	0.013	0.356	0.356
13	-0.026	-0.426	0.426
12	-0.083	-2.257	2.257
11	-0.135	-3.592	3.592
10	-0.133	-3.788	3.788
9	-0.217	-6.528	6.528
8	-0.280	-9.027	9.027
7	-0.367	-11.745	11.745
6	-0.422	-12.721	12.721
5	-0.440	-14.013	14.013
4	-0.434	-13.773	13.773
3	-0.426	-13.423	13.423
2	-0.468	-14.542	14.542
1	-0.499	-15.604	15.604

T-test (US - all industries/all events)			
days	CAAR	t value	abs value
15	-0.298	-7.711	7.711
14	-0.280	-7.503	7.503
13	-0.252	-6.664	6.664
12	-0.304	-9.293	9.293
11	-0.245	-7.707	7.707
10	-0.224	-7.407	7.407
9	-0.188	-6.370	6.370
8	-0.229	-7.266	7.266
7	-0.243	-7.906	7.906
6	-0.302	-9.383	9.383
5	-0.328	-9.748	9.748
4	-0.280	-8.637	8.637
3	-0.271	-8.521	8.521
2	-0.283	-8.837	8.837
1	-0.228	-7.230	7.230

Source: Own work.

Table 3: Empirical results, two-tailed t-test, both markets (all industries/decreasing rates)

T-test (Europe - all industries/dec. rates)			
days	CAAR	t value	abs value
5	-0.068	-1.137	1.137
4	-0.060	-1.568	1.568
3	-0.136	-3.086	3.086
2	-0.272	-5.757	5.757
1	-0.252	-5.169	5.169

T-test (US - all industries/dec. rates)			
days	CAAR	t value	abs value
5	-0.233	-3.474	3.474
4	-0.183	-3.685	3.685
3	-0.108	-2.436	2.436
2	-0.133	-2.316	2.316
1	-0.072	-1.283	1.283

"(table continues)"

Table 3: Empirical results, two-tailed t-test, both markets (all industries/decreasing rates), (cont.)

T-test (Europe - all industries/dec. rates)			
days	CAAR	t value	abs value
10	-0.556	-9.436	9.436
9	-0.648	-13.024	13.024
8	-0.675	-13.736	13.736
7	-0.686	-13.822	13.822
6	-0.695	-13.644	13.644
5	-0.731	-14.605	14.605
4	-0.726	-14.358	14.358
3	-0.811	-15.757	15.757
2	-0.946	-18.157	18.157
1	-0.923	-17.956	17.956

T-test (US - all industries/dec. rates)			
days	CAAR	t value	abs value
10	-0.302	-4.724	4.724
9	-0.201	-3.854	3.854
8	-0.201	-3.134	3.134
7	-0.205	-3.259	3.259
6	-0.259	-4.263	4.263
5	-0.397	-6.867	6.867
4	-0.348	-6.519	6.519
3	-0.275	-5.323	5.323
2	-0.300	-5.413	5.413
1	-0.238	-4.398	4.398

T-test (Europe - all industries/dec. rates)			
days	CAAR	t value	abs value
15	-0.186	-2.977	2.977
14	-0.153	-2.042	2.042
13	-0.146	-1.281	1.281
12	-0.277	-4.420	4.420
11	-0.288	-4.192	4.192
10	-0.229	-3.517	3.517
9	-0.318	-5.764	5.764
8	-0.345	-6.319	6.319
7	-0.363	-6.702	6.702
6	-0.378	-7.137	7.137
5	-0.414	-8.044	8.044
4	-0.416	-8.140	8.140
3	-0.503	-9.772	9.772
2	-0.641	-12.501	12.501
1	-0.615	-12.134	12.134

T-test (US - all industries/dec. rates)			
days	CAAR	t value	abs value
15	-0.734	-12.170	12.170
14	-0.701	-11.130	11.130
13	-0.651	-10.215	10.215
12	-0.799	-14.851	14.851
11	-0.786	-15.078	15.078
10	-0.792	-15.068	15.068
9	-0.690	-13.476	13.476
8	-0.690	-13.143	13.143
7	-0.693	-13.113	13.113
6	-0.750	-13.995	13.995
5	-0.887	-16.225	16.225
4	-0.837	-15.939	15.939
3	-0.766	-14.462	14.462
2	-0.789	-14.629	14.629
1	-0.725	-13.758	13.758

Source: Own work.

In this main part of the empirical research, two-sided t-tests are exhibited. One-sided t-tests are exhibited in the Appendix part of the thesis. The results show that the null hypothesis is rejected for the European stock market index, Europe STOXX 600, where all industries and all events are included, under the 10-days event window lag and under the 15-days event window lag. For the 5-day lag, it is accepted. The most significant statistical evidence, where the impact of the key interest rate changes on stock market performance exists, is exhibited under the 10-day window lag. The trend shows that by increasing the days prior and posterior the event mean beyond 15 days, moves the abnormal return curve closer to expected returns, and the null is accepted again as in the five-day event window case. The situation with the US market is somewhat different. Namely, the statistically significant impact is observed in the case of a 15-day event window lag, hence more strongly in the case of a two-tailed t-test. The trend exhibits that as event windows are extended from 15 days (15 days included) onwards, the null is rejected. In the case of a 10-day lag, the null is overall rejected and in the case of a 5-day lag, the null is completely rejected, as is exhibited by the two-tailed t-test. Data are observable in Table 2. These discrepancies are strongly aligned with the assumptions already proposed. Namely, the key interest rate changes are assumed to be

partially exogenous event forms, where the announcements are published in advance and markets short-termly adjust. One-sided t-tests for these analyses are in Appendix 6 and 7.

Table 4: Empirical results, two-tailed t-test, both markets (all industries/increasing rates)

T-test (Europe - all industries/inc. rates)			
days	CAAR	t value	abs value
5	0.074	1.540	1.540
4	0.050	1.184	1.184
3	0.134	3.521	3.521
2	0.163	3.950	3.950
1	0.061	1.491	1.491

T-test (US - all industries/inc. rates)			
days	CAAR	t value	abs value
5	-0.142	-3.221	3.221
4	-0.089	-1.845	1.845
3	-0.128	-3.173	3.173
2	-0.121	-3.302	3.302
1	-0.067	-1.868	1.868

T-test (Europe - all industries/inc. rates)			
days	CAAR	t value	abs value
10	0.136	2.787	2.787
9	0.096	1.394	1.394
8	0.065	0.612	0.612
7	-0.026	-1.622	1.622
6	-0.115	-3.773	3.773
5	-0.124	-3.472	3.472
4	-0.149	-3.922	3.922
3	-0.064	-1.582	1.582
2	-0.035	-0.824	0.824
1	-0.138	-3.390	3.390

T-test (US - all industries/inc. rates)			
days	CAAR	t value	abs value
10	0.240	5.211	5.211
9	0.223	5.524	5.524
8	0.144	3.757	3.757
7	0.121	2.834	2.834
6	0.060	1.513	1.513
5	0.106	3.446	3.446
4	0.150	4.382	4.382
3	0.115	3.405	3.405
2	0.112	3.093	3.093
1	0.155	4.261	4.261

T-test (Europe - all industries/inc. rates)			
days	CAAR	t value	abs value
15	0.038	0.778	0.778
14	0.025	-0.450	0.450
13	-0.028	-2.292	2.292
12	-0.052	-3.160	3.160
11	-0.103	-3.669	3.669
10	-0.158	-5.151	5.151
9	-0.197	-5.731	5.731
8	-0.227	-6.422	6.422
7	-0.318	-8.582	8.582
6	-0.410	-10.510	10.510
5	-0.419	-10.609	10.609
4	-0.444	-11.134	11.134
3	-0.360	-8.870	8.870
2	-0.331	-8.199	8.199
1	-0.435	-10.870	10.870

T-test (US - all industries/inc. rates)			
days	CAAR	t value	abs value
15	0.060	1.219	1.219
14	0.070	0.808	0.808
13	0.077	1.463	1.463
12	0.088	2.099	2.099
11	0.170	4.202	4.202
10	0.215	5.001	5.001
9	0.200	4.959	4.959
8	0.122	3.155	3.155
7	0.098	2.365	2.365
6	0.035	0.900	0.900
5	0.084	2.628	2.628
4	0.133	3.879	3.879
3	0.098	2.754	2.754
2	0.094	2.512	2.512
1	0.139	3.703	3.703

Source: Own work.

The alignment with announced changes is short-termly defined in time reference points, and the sufficiently significant statistical impact does exist. It is mainly the case for the highly sensitive industries, which hold the highest weight portion in the overall stock index average. Table 3 and 4 exhibit empirical results for the settings of only decreasing and only increasing interest rate effects on the stock market's overall performance for both economies. Here, all industries are included in the analysis. Table 3 and 4 outline the results for the two-sided t-statistic. However, one-sided t-tests for both respective settings are exhibited in Appendix 8, 9, 10 and 11. Decisions based, solely, on decreasing interest rates show to have overall bigger impact than the ones based on interest rate increases. Under decreasing rates, the impact of

events on the European stock market exhibits very similar behavioural pattern as in the case of all included interest rate changes. The highest degree of statistically significant impact has the 10-day event window lag. It is fair to conclude, that the highest weight in the case of all-included events, for the event-impacted scenarios, hold decreasing interest rates.

Contrary, the setting with only increasing rates in the case of the European stock market, results in rejected null for the event window lags of 10-day and 15-day, yet overall accepted null for the setting of a 5-day event window. For the latter, the null is strongly accepted for the days one, four, and five window deviation from event mean by two-sided t-test, where one-sided t-test shows that the empirical result mostly stems from the period after the event taking place. The case of the US stock market, in terms of empirical results, is strong in rejecting the null under 5, 10, and 15-day event window settings when rates are decreasing, and is medium-strong in rejecting the null for all the event window settings when rates are increasing. This means that a lower statistically significant event impact is exhibited when interest rates are increasing, and a stronger impact is exhibited when interest rates are decreasing, especially for the larger event lags. It is very important to point out that analyses sample all index industries and industry sensitivity diminishes as number of industries rises.

The next part of the analysis includes only sampled industries for both markets. All of these samples are constrained to three, where industry sensitivity analysis becomes more evident. The first sample for the European market includes the oil and gas industry, basic resources, and food and beverage sectors. The statistical testing includes only the setting under the 5-day event window "benchmark" lag. For both markets, each of the two samples includes three settings. These three scenarios are: impact of all events, impact of only decreasing interest rates, and impact of only increasing interest rates. Statistical testing includes, again, the one-tailed and the two-tailed t-test analysis. The one-tailed t-test statistic is exhibited in Appendix 12 and 13, whereas the two-tailed t-test statistic is presented in Tables 5 and 6.

If Table 5 is observed, the two-tailed t-test statistic strongly rejects the null for the US market in settings of all events and in the setting of decreasing rates, yet less strongly (but still rejects the null) for the setting of increasing rates. The first sample for the US market consists of the energy sector, consumer staples, and consumer discretionary sector. For the European market, the case is somewhat different. For the settings of all events and decreasing rates, the null is overall rejected and a far lower significant impact is observed than is the case with the US market for the same settings. Only the cumulative 3rd day in the case of decreasing rates, and the cumulative 4th and 5th day of all event settings show no statistically significant impact, and for these individual days, the null can be accepted. Yet, for the case of increasing rates, the null is completely rejected, most strongly for the cumulative 2nd and 3rd days. The first samples exhibit a firmly significant event impact on both stock market performances.

Table 5: Empirical results, two-tailed t-test, both markets (the first sample)

T test (Europe - three industries/all events)			
days	CAAR	t value	abs value
5	-0.175	-1.913	1.913
4	0.134	0.936	0.936
3	0.413	5.300	5.300
2	0.218	2.748	2.748
1	-0.290	-3.729	3.729

T test (US - three industries/all events)			
days	CAAR	t value	abs value
5	-0.623	-8.054	8.054
4	-0.557	-8.045	8.045
3	-0.579	-9.347	9.347
2	-0.585	-8.819	8.819
1	-0.510	-7.998	7.998

T test (Europe - three ind./dec. rates)			
days	CAAR	t value	abs value
5	-0.710	-5.225	5.225
4	-0.263	-2.505	2.505
3	-0.060	-0.732	0.732
2	-0.271	-2.482	2.482
1	-0.472	-4.190	4.190

T test (US - three ind./dec. rates)			
days	CAAR	t value	abs value
5	-1.015	-7.917	7.917
4	-0.988	-8.451	8.451
3	-0.950	-9.417	9.417
2	-1.086	-9.994	9.994
1	-0.978	-9.263	9.263

T test (Europe - three ind./inc. rates)			
days	CAAR	t value	abs value
5	0.420	3.327	3.327
4	0.735	6.992	6.992
3	1.117	10.884	10.884
2	1.149	10.162	10.162
1	0.492	4.666	4.666

T test (US - three ind./inc. rates)			
days	CAAR	t value	abs value
5	-0.339	-3.630	3.630
4	-0.243	-2.928	2.928
3	-0.322	-4.162	4.162
2	-0.235	-2.997	2.997
1	-0.180	-2.333	2.333

Source: Own work.

As the banking sector, i.e., financial sector in general, is highly sensitive to central banks' key interest rate changes, empirical results in Table 6 comply to such assumptions. The second sample of the European market is formed of banking sector, insurance sector and real estate sector. The US market second sample consists of financials sector, real estate sector and industrials sector. The one-tailed t-test firmly rejects the null hypothesis for the scenarios of all-events impact and impact under decreasing rates for the European market. Whereas, the two-tailed t-test rejects the null for all three scenarios for the European market. This means that statistically significant impact is exhibited in these cases. In the case of one-tailed t-test (Appendix 13), the null is rejected for the case of increasing rates for the European market. All three scenarios for both markets are analysed under the "benchmark" 5-day lag.

Nonetheless, if we observe results of the two-tailed t-test, Table 6 (below), the first two cases strongly reject the null ($|t\ value| > 10$) and the third case rejects the null for the all-cumulative days, however less strongly than the first two settings. Results as such show that European financial stocks are, in overall terms, sensitive to the ECB's policy changes; yet, they are more sensitive to decreasing rate policy changes than increasing ones. On the other hand, very surprising results are reached in the case of the US stock market. The US stock market exhibits different behavioural patterns. Nonetheless, the two-sided t-test statistic shows that the US stock market (financials sector) is not sensitive to federal funds changes, as might be expected. Table 6 exhibits results for the second sample of the US stock market as well. The t-statistic accepts the null in the case of the second US stock market sample for scenarios of all events and increasing rates, i.e., no overall impact is observed. The setting including

decreasing interest rates overall rejects the null, especially for the cumulative days one, two, and three. However, the composition of the US market sample differs, due to the inclusion of the industrials sector in the sample. It can be concluded that this industry holds a substantial weight within the sample and brings upon acceptance of the null. If the industrials sector were excluded, a higher impact of the event could be expected.

The reason why the industrials sector is added to the US sample is to keep the number of sampled participants the same for both markets. As industrials sector firms are large in their scope of operations, their cash flows and revenues are as high as are in the financial sector companies, this very industry is added to the sample. Another reason is found in the stability of their stocks. However, as is observed from Table 6, it is highly probable that the US second sample would be much more sensitive to federal funds changes if this industry were excluded. Nonetheless, the European market sample shows that the financial and real estate sectors are highly sensitive to key interest rate changes. Moreover, these sectors are much more sensitive to decreasing than to increasing key interest rate changes.

Table 6: Empirical results, two-tailed t-test, both markets (the second sample)

T test (Europe - three industries/all events)			
days	CAAR	t value	abs value
5	-0.696	-7.793	7.793
4	-0.727	-8.335	8.335
3	-1.027	-13.400	13.400
2	-1.062	-13.469	13.469
1	-1.013	-13.596	13.596

T test (US - three industries/all events)			
days	CAAR	t value	abs value
5	-0.137	-1.964	1.964
4	-0.014	-0.276	0.276
3	0.060	1.313	1.313
2	0.109	1.268	1.268
1	0.183	3.082	3.082

T test (Europe - three ind./dec. rates)			
days	CAAR	t value	abs value
5	-0.964	-6.554	6.554
4	-0.984	-6.418	6.418
3	-1.580	-12.661	12.661
2	-1.890	-14.988	14.988
1	-1.793	-14.526	14.526

T test (US - three ind./dec. rates)			
days	CAAR	t value	abs value
5	-0.154	-1.225	1.225
4	0.060	0.096	0.096
3	0.217	2.044	2.044
2	0.484	3.942	3.942
1	0.508	4.902	4.902

T test (Europe - three ind./inc. rates)			
days	CAAR	t value	abs value
5	-0.360	-3.293	3.293
4	-0.428	-4.355	4.355
3	-0.416	-4.435	4.435
2	-0.328	-3.237	3.237
1	-0.520	-5.468	5.468

T test (US - three ind./inc. rates)			
days	CAAR	t value	abs value
5	-0.146	-1.772	1.772
4	-0.078	-0.634	0.634
3	-0.051	-0.299	0.299
2	-0.154	-2.365	2.365
1	-0.048	-0.770	0.770

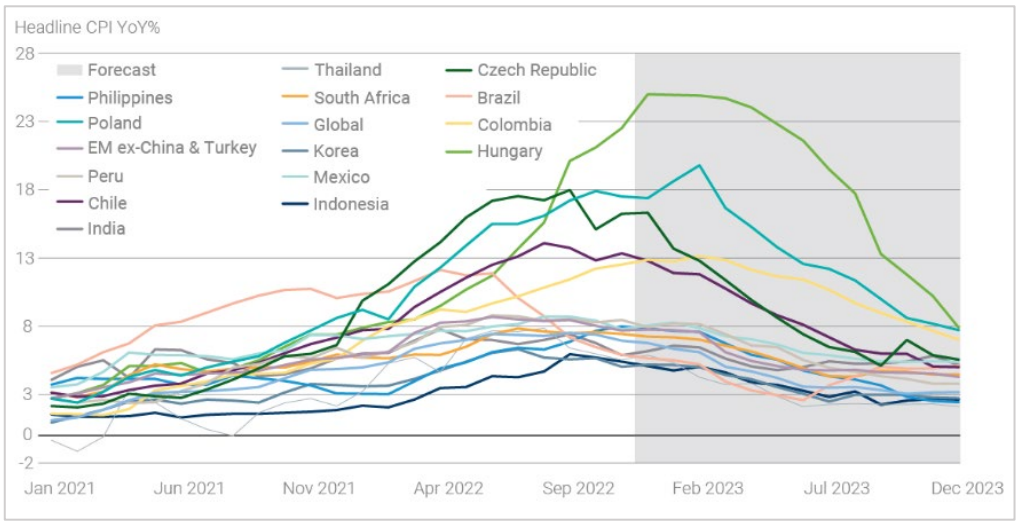
Source: Own work.

In the end, it is important to point out again, that each graphical CAAR values are cumulative and that each tabular CAAR values are based on daily frequency levels throughout the thesis.

5.4 Emerging markets outlook

Emerging markets have exhibited many hurdles during the 2022 inflationary pressure. The MSCI index exhibits their average recovery during the last quarter of the 2022. If we look at Figure 22, the year 2022 shows vigorous inflation rates for the majority of emerging markets, yet fairly high inflation rates for the rest. The most interesting inflation hikes are observed with the European Union member states, namely Hungary, Poland, and the Czech Republic. All three joined the EU in 2004, yet they still process their path toward becoming developed economies struggling to reach adequate levels of market efficiency and satisfactory levels of regulatory standards. Hungarian inflation rate is shown to be the highest from the midterm of 2022, then come Poland and the Czech Republic in second and third place, among all sampled emerging markets (as can be seen from Figure 22). Colombia and Chile follow these three countries. The forecast, shaded in grey, shows how the inflation rates are about to lessen to the average level and get closer to the lower sampled bound by the end of the year 2023.

Figure 22: Emerging markets, inflation rates and forecast



Source: Lazard Asset Management (2023).

The J.P. Morgan Global Research, 2023, points out that the projection of the global economy expansion in 2023 is around 1.6%, while for the emerging markets it amounts to 2.9%. China alone is likely to exhibit expansion of 4.0% for the 2023. Developed markets are projected to exhibit growth of 0.8%. The US forecast is better looking than the one for the eurozone, the two are expected to exhibit poor growths overall, the US 1.0% and 0.2% growth for the eurozone area. This projection alone points out the larger impact of the 2022 ongoings on the European economies than on the US economy. The research further points out that at 2.9% of projected growth, emerging markets remain below their pre-pandemic trend. China holds sufficient weight in emerging markets' average growth projection, with an estimation of 4%, as a consequence of loosening Covid restrictions. It is important to say that the main drivers for the emerging markets assets are global and the US economic cycles. The forecast highlights that the same is true for the 2023 projections. After the high drops in equity

markets during the 2022, emerging markets equity prices are projected to exhibit fairly good recovery process, although critically depending on the US dollar movement. Debt assets performance for emerging markets has never been worse than it showed to be during 2022.

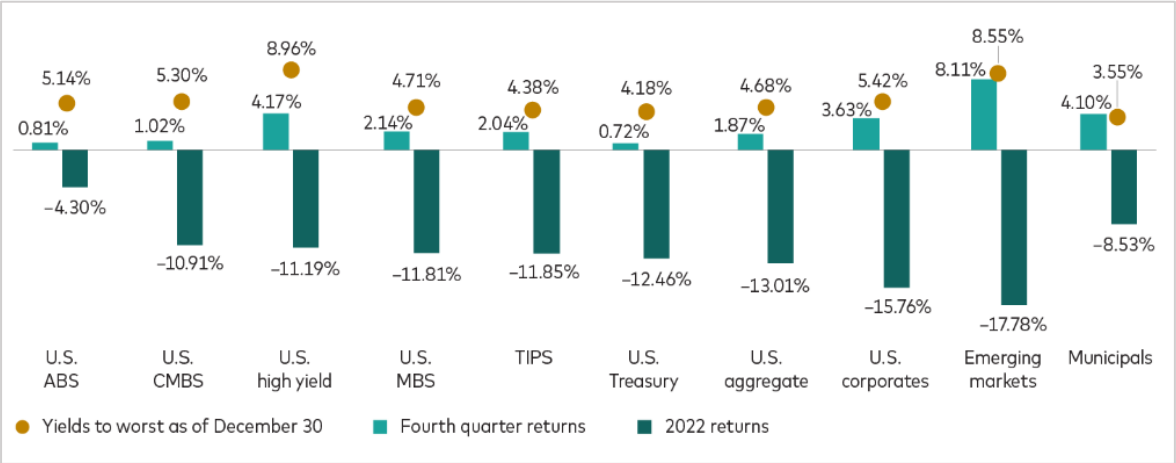
Yet, the forecast for 2023 tends to be quite positive, due to attractive valuations and elevated yields for fixed income assets. Interest rate ease is still far away for majority of emerging economies, despite the expected disinflation period. Interest rate cuts might be expected in Latin America, while other central banks will most probably leave their rates high. Turkey and Argentina are expected to be under additional stress due to expected elections. Overall, under continued US dollar strengthening - which is in opposite correlation with the emerging markets' real activity, high inflation rates, global financial tightening measures, easing cycles are not expected to take place for the majority of emerging market economies. It is, however, expected that Latin America, the Czech Republic, and India do exhibit some relief in 2023.

5.5 Interest rate hikes and bond yields, FX rates and commodity markets

Tightening monetary policy is seen to be the key driver of all asset prices, during the 2022. The beginning of 2023 continued at the same pace, with expectations of interest rate cuts as the year 2023 comes to an end. Moving between the edges of keeping prices stable and low unemployment rate, the Federal Reserve System had to sacrifice certain points of their economic development, and even negatively affect some areas in order to combat raging rate of inflation. As inflation rate hikes can have negative long-term consequences, the fear of eroding corporate earnings, increasing credit spreads and defaults was among FED’s biggest risks. By slowing down economic activity, the possibility of entering into recession was the risk number one. Yet, the FED announced, at the beginning of 2023, that the possibility of entering into recession is highly unlikely and announced that the interest rate increase policy will be continued in the first half of the year, however, in smaller increments compared to 2022. The previous year was not a positive year for bond market performance globally.

Not only high-yield bonds but also low-yield bonds exhibited negative returns in 2022. By looking at Figure 21, the largest burden was undertaken by the US corporate bonds, whose returns in overall terms for the whole 2022 year dropped by 15.76%. High-yield bonds saw a decrease of 11.19%. It is interesting to observe that the US Treasuries, government bonds, also exhibited negative overall returns, dropping by 12.46%. As high inflation rates pushed financial market risks upwards, the yields – representing investors’ returns on bond interest, exhibited increasing trend movements. The last quarter of 2022 was a start to recovery, not only for emerging markets but also for developed markets. Even though the US corporates were the worst-performing bond types in overall terms, they exhibited the best positive returns in the last quarter, amounting to 3.63%, right after the high-yield bonds with 4.17%.

Figure 23: The US 2022 different bond types' returns and yields



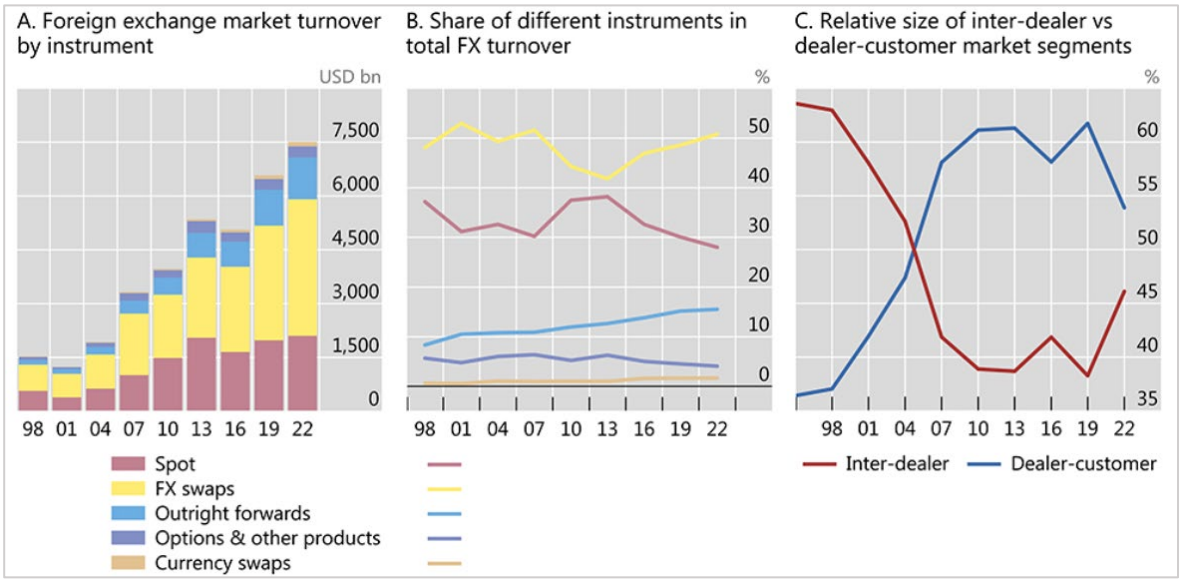
Source: The Vanguard Group Inc. (2023).

The higher the interest rates, steeper the yield, is a short overview of the US bond market in 2022. The market future projected trend is brighter, especially regarding the US Treasuries. Yet, the recent future will show us how different the actual data are going to be from all of these projections. The EU bond market is even more hit by the 2022 crisis, than the US bond market. The mostly hit bonds were European high-yield bonds and corporate bonds. Due to geopolitical instability, energy supply reduction, ongoing war, and high inflation rates, the ECB's tightening form of monetary policy led to lowered spending rates and increased borrowing costs. Increased costs of borrowing directly influenced the issuance of high-yield bonds. This form of asset class exhibited a tremendous fall in 2022, after the record issuance rate in 2021. The fear of high default risk was one of the main investors' concerns. The PwC, Debt Watch Europe 2022 Annual Review, points out that the volume and the number of high-yield bond issuances in 2022 were more than 60% lower than in 2021. The corporate European bond market exhibited the volume and the number of bond issuances lower by about 25% than in 2021. European government bonds exhibited negative annual return rates.

The foreign exchange market was not left without consequences in 2022, it exhibited higher volatility than usual. Amid the high volatility trends, the global forex market managed to exhibit an increasing turnover trend in comparison to previous years. BIS quarterly review, from the end of the year 2022, points out that the global market turnover averaged more than 7.5 trillion US dollars per day in April 2022. Compared to previous years, the increase is due to greater activity in short-maturing foreign exchange derivatives and more inter-dealer types of trading. Consequences of crisis were felt in a segment of trading with customers, mirroring a slowdown in international investment in 2022. The highest turnover was performed by FX swaps, then spot, and at third place by outright forwards. The least amount of turnover was obtained on the basis of instruments such are options, currency swaps, and other assets. These data can be most easily understood by looking at Figure 24. FX swaps intake in global market turnover in 2022, weigh slightly above 50%. Last, but not the least, the commodity markets, as pointed out in Goldman Sachs, 2022 Commodities Research, were highly likely

to finish the year as the best performing class in 2022, despite the price volatility. One of biggest problems faced globally was the oil and gas supply shortage, due to war conflict. As commodity market was dominated by the dollar in 2022, underinvestment is next to follow.

Figure 24: *Global FX trading volume trends and other indicators, 1998-2022*



Source: Bank for International Settlements (2022).

CONCLUSION

This Master's thesis implies several important impact reference points. The first implies that the change in monetary policy has significant impact on the stock market behaviour. Even though, the announcements of central banks are not purely exogenous events, statistically significant impact still remains. This behaviour of stock markets exhibits its firm sensitivity to interest rate changes, and the period between the announcement and the implementation of the policy shows not to be enough for the markets to completely adjust to these forms of information sets. Hence, the stock market shocks exist. The second point implies that the stocks are, on average, more sensitive to policies of decreasing interest rates, rather than to policies of increasing interest rates. The year 2022 has been hard for all asset categories, but mostly for the bond and stock markets. Moreover, the thesis implies the negative impact of the high inflation rates on all asset classes but also exhibits the movement patterns and interdependency among different asset classes in a highly inflationary environment. The most important intermarket asset behaviour is analysed among bond and stock markets. The thesis, also, exhibits the differences in asset class behaviour in cases of developed and emerging markets. Emerging markets tend to deal with higher levels of market risk and their equity market movement highly depends on the equity trends of developed markets, especially the United States and the European Union. Commodity markets and foreign exchange markets exhibited a somewhat lower negative impact in 2022 than is the case with fixed income and equity asset classes. Portfolio diversification was hard to be achieved with

an interchange of stocks for fixed-income assets since the bond markets were in a highly risky state during the year 2022. High inflation rate boosted high negative returns on even low-risk bond classes, such are government or Treasury bonds. The positive and negative t-test values in relative terms show the pattern of the impact of monetary policy key interest rate changes on stock market performance. One of the most interesting differences between the US and the European stock indices is found in the movement of abnormal stock returns due to increasing and decreasing rate changes. Whilst for the European market, decreasing rates exhibit negative deviation in abnormal return movement from expected return values and increasing rates exhibit positive deviation, the US stock market abnormal returns exhibit a negative deviation pattern for both increasing and decreasing rates. The highest sensitivity to interest rate changes is exhibited in financial sectors. Although similar, the thesis outlines the main differences among indices.

Findings and inference

The main purpose of the thesis was to test for the effects of the key interest rate changes on the stock market performances of the European and the United States stock markets. The main institutions in charge of the monetary policy of these economies are the European Central Bank and the Federal Reserve System, respectively. This research thesis aimed to combine the monetary policy and equity market as the two main cause-effect reference points. The analyses included a historical time series incorporating the time span of the last twenty-three years. This time-series period refers to the stock daily prices for both markets and historical interest rate changes for both markets. The main representatives of the economies' stock markets were the Europe STOXX 600 and the S&P 500 indices. The thesis based its analysis on the event study methodology and multivariate regression. The stock return normalization was performed under the methods of the market model since it was found to be the most suitable one.

The event study methodological analysis was performed under varying event windows and different sample settings. Although the 5-day event window was the "benchmark" lag, the thesis tested for the 1, 10, 15, 30, and 60 window days. The null hypothesis was based on the assumption that standardized cumulative abnormal returns across industries equal to zero, i.e., no impact was observed. Empirical results, hence, show that in overall terms there is a statistically significant impact of interest rate changes on the stock market performance, for both markets. Since the analysis is multivariate, and many conditional settings were analysed, results differ from one conditional setting to another. The null is rejected for the majority of the settings, exhibiting the interdependence among the central banks' key interest rates and stock markets; yet, exhibiting the largest impact on the financial industry and decreasing interest rate conditions. For the European market, the most statistically significant result and the largest impact, in the all-events case, is obtained under the 10-day event window setting, whereas the US stock market exhibited in the case of 15 and larger than 15-day event window setting. The markets differ in obtained results. Another set of analyses

included intermarket asset behavioural analysis, especially among the stock and bond markets within the inflationary environment. Other asset classes were analysed as well, such are commodity market assets and foreign exchange market assets. Asset class research is done for emerging markets, as for developed markets. The strongest evidence for emerging markets is that the equity asset movement highly depends on the equity market movement of the developed economies. Although the raging inflation rates from 2022 are now exhibiting a pattern of decrease, as a consequence of imposed monetary measures, the time of economic slowdown is still a worrying category for the year 2023. The main reason regards the time period in which the monetary policy of increasing rates will remain. The mid-term and long-term consequences are still to be observed during the 2023 event(s) development. The war conflict still remains and the challenges for the European Union to settle new energy supply trade agreements. The pressure on the stock and bond markets still remains. However, if the recession, as the mid- and long-term consequence, is to be avoided by the end of 2023, the markets will move towards a higher level of the stabilization process.

The main recommendation for the future research thesis, when all considered, is to undertake the research in the direction of each crisis individually and compare the level of interest rate shocks under uniquely defined crisis scenarios. It would be an interesting point to observe how much stock market shocks differed under each specific crisis. It would, nonetheless, be interesting to perform the same detailed analysis on other asset classes and extract the impact of interest rate changes on their behavioural pattern. One of the most important and most relevant recommendations, however, would be to perform the same analysis, but with the time-series division before and after the 2008 crisis with increasing and decreasing rates.

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APPENDICES

Appendix 1: *Summary in Slovene language (Povzetek v slovenščini)*

Magistrsko delo analizira vpliv dogodkov na borzno delovanje dveh razvitih gospodarstev, oziroma evropskega in ameriškega borznega trga. Dogodki so posledica zgodovinskih sprememb ključne obrestne mere s strani Evropske centralne banke, kot glavne institucije denarne politike za evroobmočje in Sistema zveznih rezerv, institucije za reguliranje denarne politike Združenih držav Amerike. Študija dogodka vključuje podaljšane časovne vrste za zadnjih 23 let, in sicer od začetka leta 1999 do začetka leta 2023. Časovna vrsta je določena na podlagi presečišča podatkov za obe centralni banki, v cilju doseganja skladnih rezultov. Ker je bila ECB ustanovljena leta 1998, je treba vzporedne nize podatkov edinstveno ekstrahirati na podlagi take časovne determinante. Poudarek za evropski trg je sprememba glavne obrestne mere za operacije refinanciranja, obrestne mere mejnega depozita in obrestne mere mejnega posojila, medtem ko je za ameriški trg fokus na zgodovinskim spremembam obrestne mere zveznih skladov.

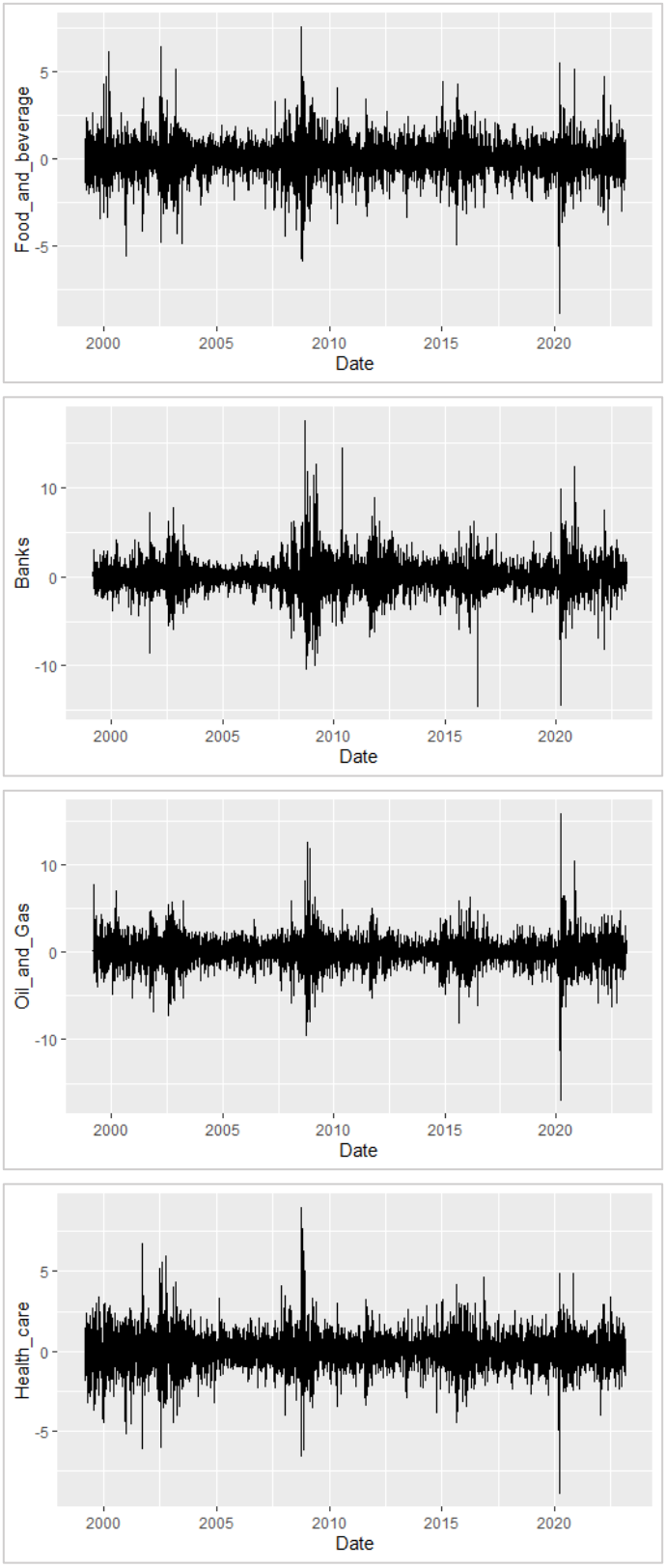
Analize zajemajo vse spremembe ključnih obrestnih mer za določeno časovno obdobje za oba trga. V tem časovnem obdobju je bilo 51 sprememb obrestne mere s strani ECB in 71 sprememb obrestne mere s strani FED. Izbrana približka za borzno predstavo sta evropski STOXX 600 indeks in indeks S&P 500. Analiza temelji na metodologiji študije dogodkov z diferenciacijo determinant okna dogodkov. Multivariatna regresija se uporablja za sklepanje o obnašanju abnormalnih donosov pri različnih omejitvah. Normalizacija donosov temelji na tržnem modelu v postopku ocenjevanja. Časovne in presečne spremembe v gibanju abnormalnih donosov se testirajo glede na statistično pomembnost statističnega združevanja t-testa. Analize vključujejo kumulativno testiranje deviantnih donosov za obe razviti gospodarstvi z ekstrapolacijo njunih posameznih panog iz borznih indeksov. Za oba trga je testiran vzorec vseh panog ter vzorčene skupine specifičnih panog, kot so tiste, ki jih je kriza leta 2022 najbolj prizadela, ter finančne panoge nasploh.

Magistrsko delo poglobljeno obravnava kumulativne rezultate, pa tudi specifične rezultate, pri čemer so dogodki razdeljeni v dve ločeni skupini naraščajočih in padajočih ključnih obrestnih mer, ki se dodatno testirajo na vsakem konkretnem vzorcu. Magistrsko delo obravnava metodologijo študije dogodkov kot analizo kratkoročne študije dogodkov, kjer okna dogodkov ne presegajo 60-dnevnega zamika. Takšna oblika kratkega zamika je zelo pomembna za analizo, saj so delniški trgi in njihovi tečaji zelo volatilni tko da spremembe najbolj opazimo na podlagi kratkoročne analize.

Drug zelo pomemben vidik magistrske naloge je analiza nastajajočih trgov in gibanja njihovih naložbenih razredih med krizo leta 2022, vključno z začetkom leta 2023. Ko gre za evropske in ameriške finančne trge, je medtržna analiza izvedena tako, da razlaga korelacijo med naložbenimi razredi in delniškimi trgi v času visoke inflacije. Prednostni poudarek je na razmerju med obveznicami in delnicami, predvsem pa na podjetniških obveznic in državnih obveznic. Vendar pa so analizirani tudi trg blaga in mednarodni devizni trg v

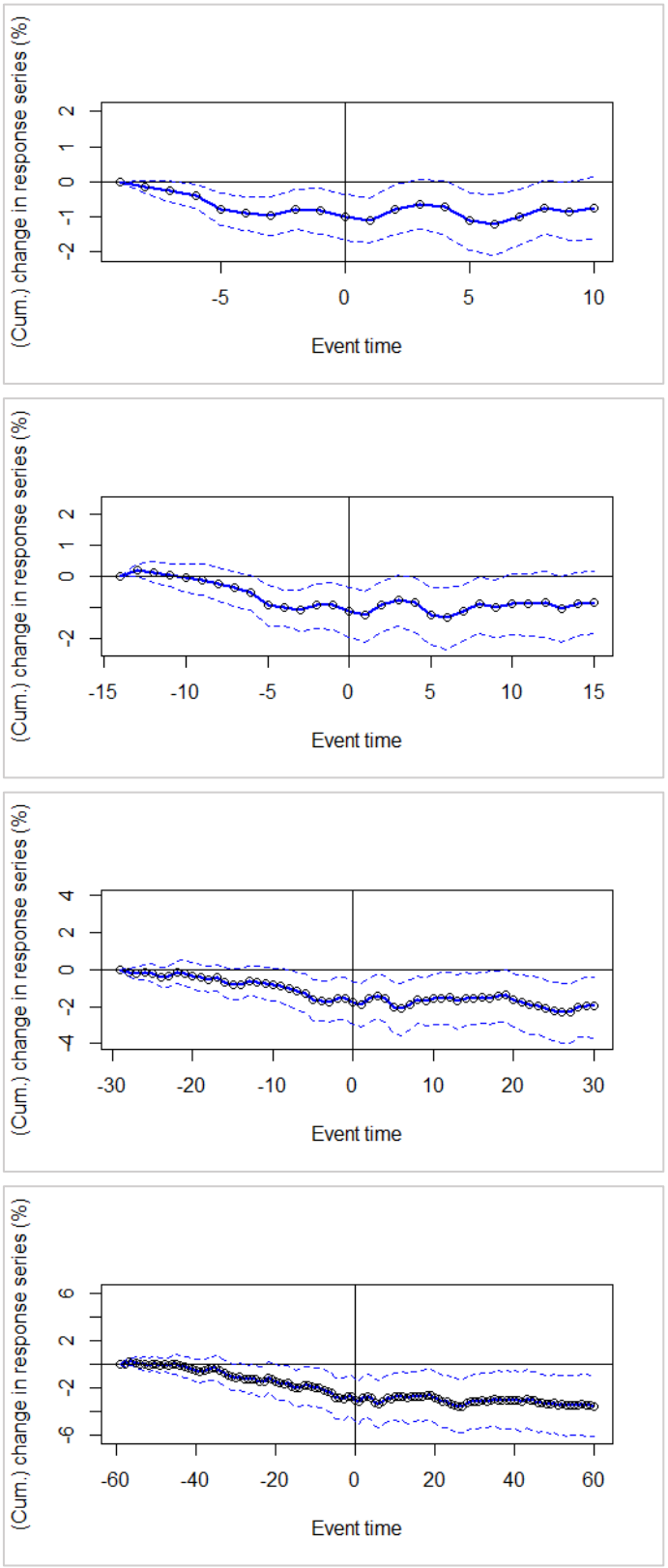
korelaciji s delniškimi tečaji v okoljih razvitih in nastajajočih gospodarstev. Na splošno rezultati kažejo na prisotnost ekonomskega vpliva dogodkov na delovanje borz v okolju teh dveh razvitih gospodarstev. Rezultati se med državami, panogami in vzorčenimi panožnimi skupinami razlikujejo, pa tudi med nastavitvami naraščajočih in padajočih obrestnih mer. Poleg drugih prizadetih panog je najpomembnejši statistični vpliv opazen v finančnih panogah, saj je sprememba ključnih obrestnih mer močno povezana z udeleženci finančnega sektorja. Uspešnost udeležencev finančnega sektorja kaže najvišjo stopnjo občutljivosti na napovedi sprememb denarne politike.

Appendix 2: *Individual industry daily returns, Europe STOXX 600, 1999-2023*



Source: Own work.
Note: Food and beverage sector, banking sector, oil and gas sector and health care sector.

Appendix 3: *Event study (event windows = 10,15,30 and 60 days), first sample, Europe*

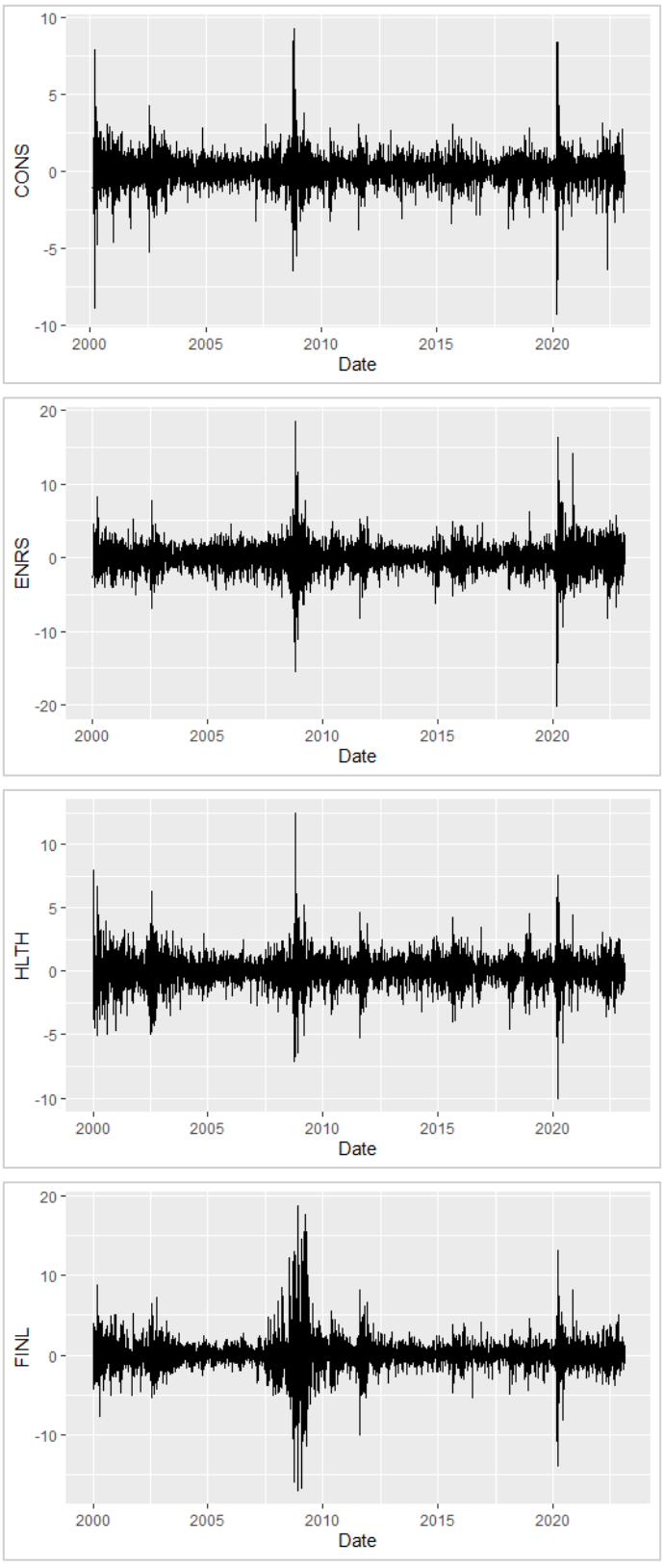


Source: Own work.

Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Note 2: Sample includes three industries: oil and gas sector, food and beverage and basic resources sectors.

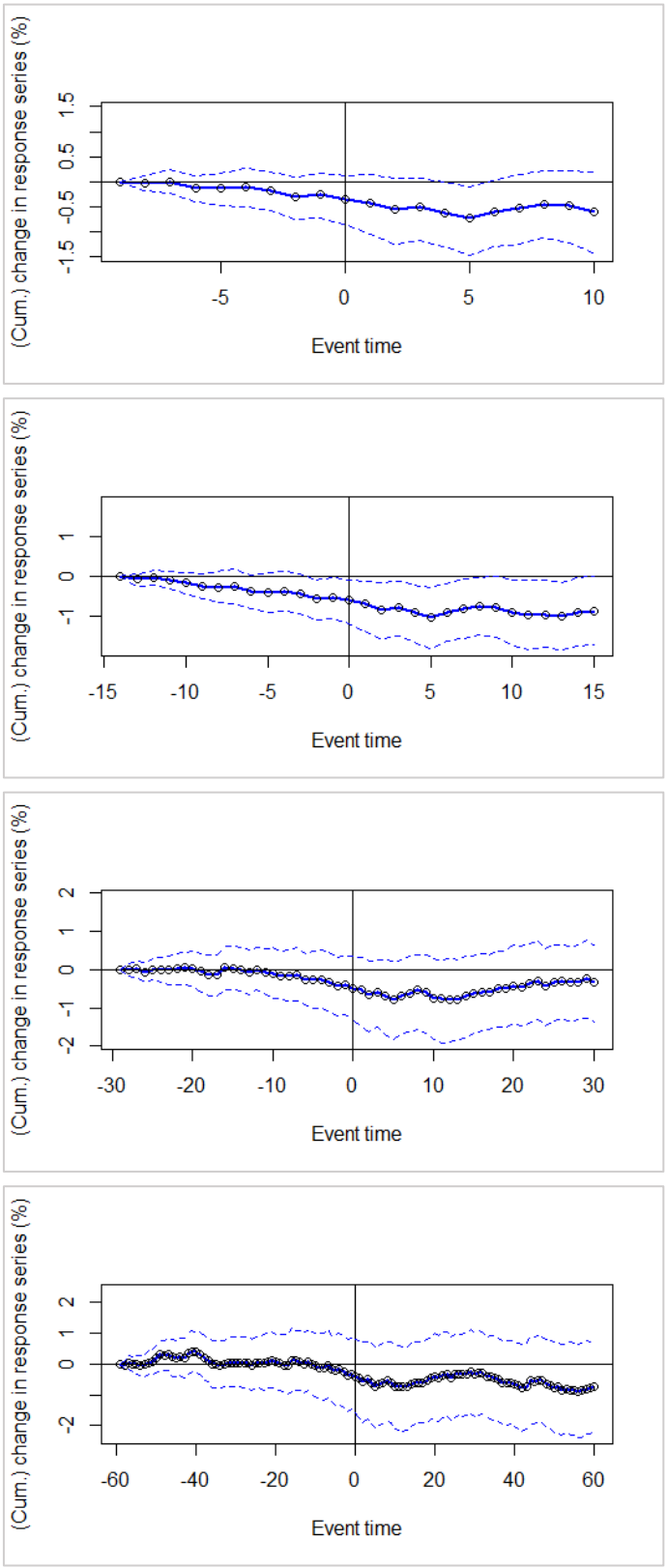
Appendix 4: *Individual industry daily returns, S&P 500, 1999-2023*



Source: Own work.

Note: Consumer staples industry (CONS), energy industry (ENRS), health care (HLTH), financials (FINL).

Appendix 5: *Event study (event window = 10,15,30 and 60 days), first sample, the US*



Source: Own work.

Note 1: Cumulative abnormal returns are calculated on the daily frequency base, time series 1999-2023.

Note 2: Sample includes three industries: consumer staples, consumer discretionary and energy sector.

Appendix 6: *One-sided t-test, all industries/all events, Europe*

T-test (Europe - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	8,160	0.000	0.000	0.000	0.000	0.000
-4	-0.096	-0.005	0.070	8,160	2.050	1.858	1.954	-0.238	0.238
-3	-0.101	0.011	0.119	8,160	2.272	2.230	2.251	0.461	0.461
-2	-0.142	0.005	0.153	8,160	2.607	2.608	2.608	0.186	0.186
-1	-0.163	0.011	0.177	8,160	2.830	2.769	2.799	0.344	0.344
0	-0.177	0.006	0.181	8,160	2.904	2.843	2.874	0.181	0.181
1	-0.191	0.001	0.185	8,160	2.976	2.916	2.946	0.026	0.026
2	-0.215	0.009	0.221	8,160	3.215	3.123	3.169	0.259	0.259
3	-0.194	0.036	0.269	8,160	3.251	3.276	3.263	0.992	0.992
4	-0.177	0.063	0.308	8,160	3.327	3.363	3.345	1.702	1.702
5	-0.227	0.047	0.303	8,160	3.551	3.439	3.495	1.208	1.208

T-test (Europe - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	16,320	0.000	0.000	0.000	0.000	0.000
-9	-0.126	-0.058	0.012	16,320	2.096	2.148	2.122	-3.514	3.514
-8	-0.221	-0.108	0.007	16,320	2.718	2.728	2.723	-5.047	5.047
-7	-0.260	-0.134	-0.007	16,320	2.875	2.868	2.871	-5.944	5.944
-6	-0.365	-0.193	-0.023	16,320	3.348	3.321	3.334	-7.381	7.381
-5	-0.400	-0.211	-0.020	16,320	3.512	3.524	3.518	-7.649	7.649
-4	-0.430	-0.220	-0.014	16,320	3.698	3.669	3.684	-7.635	7.635
-3	-0.417	-0.190	0.040	16,320	3.855	3.868	3.861	-6.271	6.271
-2	-0.434	-0.199	0.036	16,320	3.918	3.907	3.913	-6.482	6.482
-1	-0.451	-0.209	0.032	16,320	3.974	3.961	3.967	-6.734	6.734
0	-0.477	-0.225	0.024	16,320	4.052	4.030	4.041	-7.124	7.124
1	-0.503	-0.242	0.016	16,320	4.129	4.099	4.114	-7.503	7.503
2	-0.511	-0.222	0.061	16,320	4.340	4.295	4.318	-6.569	6.569
3	-0.500	-0.190	0.099	16,320	4.492	4.338	4.415	-5.495	5.495
4	-0.465	-0.166	0.126	16,320	4.417	4.359	4.388	-4.822	4.822
5	-0.510	-0.183	0.113	16,320	4.612	4.397	4.505	-5.201	5.201
6	-0.504	-0.186	0.104	16,320	4.554	4.342	4.448	-5.330	5.330
7	-0.510	-0.190	0.120	16,320	4.572	4.491	4.532	-5.347	5.347
8	-0.490	-0.134	0.190	16,320	4.818	4.595	4.707	-3.629	3.629
9	-0.516	-0.119	0.266	16,320	5.091	5.005	5.048	-3.005	3.005
10	-0.475	-0.091	0.280	16,320	5.000	4.920	4.960	-2.354	2.354

T-test (Europe - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	24,480	0.000	0.000	0.000	0.000	0.000
-14	-0.073	0.001	0.072	24,480	2.422	2.391	2.406	0.047	0.047
-13	-0.130	0.012	0.189	24,480	3.373	3.757	3.565	0.534	0.534
-12	-0.218	-0.007	0.290	24,480	4.103	4.863	4.483	-0.236	0.236
-11	-0.185	0.004	0.210	24,480	3.892	4.046	3.969	0.176	0.176
-10	-0.232	-0.018	0.219	24,480	4.138	4.343	4.241	-0.650	0.650
-9	-0.293	-0.074	0.157	24,480	4.186	4.297	4.241	-2.723	2.723
-8	-0.329	-0.122	0.110	24,480	4.056	4.307	4.182	-4.582	4.582
-7	-0.379	-0.152	0.084	24,480	4.253	4.343	4.298	-5.534	5.534
-6	-0.460	-0.213	0.050	24,480	4.439	4.583	4.511	-7.390	7.390
-5	-0.487	-0.230	0.035	24,480	4.524	4.600	4.562	-7.904	7.904
-4	-0.515	-0.241	0.034	24,480	4.676	4.687	4.682	-8.068	8.068
-3	-0.492	-0.211	0.075	24,480	4.734	4.774	4.754	-6.940	6.940
-2	-0.515	-0.223	0.076	24,480	4.834	4.886	4.860	-7.172	7.172
-1	-0.525	-0.232	0.091	24,480	4.842	5.077	4.960	-7.308	7.308
0	-0.546	-0.249	0.080	24,480	4.863	5.131	4.997	-7.805	7.805
1	-0.566	-0.267	0.070	24,480	4.883	5.184	5.034	-8.296	8.296
2	-0.567	-0.245	0.112	24,480	5.067	5.335	5.201	-7.370	7.370
3	-0.542	-0.215	0.135	24,480	5.109	5.285	5.197	-6.483	6.483
4	-0.534	-0.192	0.162	24,480	5.227	5.315	5.271	-5.705	5.705
5	-0.576	-0.210	0.146	24,480	5.411	5.326	5.368	-6.109	6.109
6	-0.803	-0.209	0.157	24,480	6.883	5.408	6.146	-5.331	5.331
7	-0.577	-0.215	0.156	24,480	5.378	5.442	5.410	-6.211	6.211
8	-0.531	-0.158	0.244	24,480	5.458	5.665	5.561	-4.444	4.444
9	-0.551	-0.143	0.319	24,480	5.704	6.072	5.888	-3.804	3.804
10	-0.519	-0.115	0.312	24,480	5.673	5.841	5.757	-3.138	3.138
11	-0.537	-0.140	0.306	24,480	5.631	5.968	5.800	-3.768	3.768
12	-0.504	-0.077	0.378	24,480	5.841	6.022	5.931	-2.021	2.021
13	-0.491	-0.038	0.459	24,480	6.016	6.299	6.157	-0.961	0.961
14	-0.450	0.012	0.506	24,480	6.078	6.275	6.177	0.310	0.310
15	-0.437	0.009	0.499	24,480	5.963	6.253	6.108	0.226	0.226

Source: Own work.

Appendix 7: *One-sided t-test, all industries/all events, the US*

T-test (US - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	7,810	0.000	0.000	0.000	0.000	0.000
-4	-0.105	-0.018	0.064	7,810	1.980	1.933	1.956	-0.830	0.830
-3	-0.152	-0.042	0.063	7,810	2.225	2.174	2.200	-1.690	1.690
-2	-0.181	-0.041	0.078	7,810	2.515	2.315	2.415	-1.484	1.484
-1	-0.207	-0.038	0.115	7,810	2.758	2.621	2.690	-1.243	1.243
0	-0.225	-0.033	0.142	7,810	2.936	2.808	2.872	-1.025	1.025
1	-0.243	-0.029	0.169	7,810	3.105	2.984	3.044	-0.836	0.836
2	-0.322	-0.085	0.137	7,810	3.275	3.161	3.218	-2.322	2.322
3	-0.317	-0.078	0.153	7,810	3.285	3.223	3.254	-2.111	2.111
4	-0.348	-0.108	0.139	7,810	3.286	3.335	3.311	-2.887	2.887
5	-0.442	-0.177	0.083	7,810	3.460	3.422	3.441	-4.538	4.538

T-test (US - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	15,620	0.000	0.000	0.000	0.000	0.000
-9	-0.072	-0.004	0.064	15,620	2.093	2.078	2.085	-0.225	0.225
-8	-0.096	0.017	0.111	15,620	2.677	2.451	2.564	0.814	0.814
-7	-0.135	-0.005	0.120	15,620	2.879	2.824	2.851	-0.219	0.219
-6	-0.159	-0.006	0.134	15,620	3.130	2.981	3.056	-0.227	0.227
-5	-0.162	0.024	0.210	15,620	3.442	3.440	3.441	0.870	0.870
-4	-0.208	0.003	0.193	15,620	3.665	3.481	3.573	0.105	0.105
-3	-0.241	-0.020	-0.020	15,620	3.752	0.000	1.876	-1.330	1.330
-2	-0.235	-0.020	0.198	15,620	3.707	3.726	3.717	-0.659	0.659
-1	-0.252	-0.018	0.220	15,620	3.862	3.897	3.880	-0.588	0.588
0	-0.266	-0.010	0.245	15,620	4.033	4.033	4.033	-0.322	0.322
1	-0.279	-0.003	0.269	15,620	4.197	4.164	4.181	-0.075	0.075
2	-0.348	-0.054	0.240	15,620	4.327	4.329	4.328	-1.562	1.562
3	-0.339	-0.042	0.253	15,620	4.348	4.343	4.346	-1.220	1.220
4	-0.380	-0.075	0.217	15,620	4.412	4.314	4.363	-2.138	2.138
5	-0.466	-0.140	0.187	15,620	4.561	4.567	4.564	-3.833	3.833
6	-0.399	-0.083	0.228	15,620	4.491	4.456	4.474	-2.325	2.325
7	-0.343	-0.026	0.308	15,620	4.493	4.619	4.556	-0.726	0.726
8	-0.368	-0.034	0.287	15,620	4.617	4.521	4.569	-0.925	0.925
9	-0.316	0.027	0.368	15,620	4.674	4.665	4.669	0.723	0.723
10	-0.367	-0.010	0.344	15,620	4.773	4.747	4.760	-0.255	0.255

T-test (US - all industries/all events)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	23,430	0.000	0.000	0.000	0.000	0.000
-14	-0.100	-0.003	0.104	23,430	2.755	2.882	2.818	-0.153	0.153
-13	-0.096	0.006	0.120	23,430	2.819	2.990	2.905	0.308	0.308
-12	-0.191	-0.057	0.083	23,430	3.242	3.300	3.271	-2.651	2.651
-11	-0.205	-0.058	0.095	23,430	3.386	3.452	3.419	-2.592	2.592
-10	-0.248	-0.083	0.088	23,430	3.589	3.658	3.624	-3.503	3.503
-9	-0.272	-0.088	0.107	23,430	3.784	3.902	3.843	-3.519	3.519
-8	-0.268	-0.071	0.137	23,430	3.928	4.021	3.975	-2.715	2.715
-7	-0.304	-0.095	0.121	23,430	4.038	4.107	4.073	-3.573	3.573
-6	-0.348	-0.100	0.137	23,430	4.398	4.305	4.351	-3.514	3.514
-5	-0.334	-0.072	0.165	23,430	4.527	4.301	4.414	-2.483	2.483
-4	-0.358	-0.093	0.162	23,430	4.552	4.464	4.508	-3.157	3.157
-3	-0.400	-0.119	0.151	23,430	4.682	4.596	4.639	-3.940	3.940
-2	-0.395	-0.121	0.155	23,430	4.623	4.649	4.636	-4.008	4.008
-1	-0.411	-0.121	0.161	23,430	4.757	4.693	4.725	-3.916	3.916
0	-0.420	-0.114	0.182	23,430	4.887	4.812	4.849	-3.606	3.606
1	-0.429	-0.108	0.203	23,430	5.013	4.928	4.971	-3.313	3.313
2	-0.497	-0.161	0.171	23,430	5.124	5.097	5.110	-4.830	4.830
3	-0.482	-0.152	0.179	23,430	5.075	5.080	5.078	-4.581	4.581
4	-0.526	-0.187	0.173	23,430	5.145	5.302	5.224	-5.480	5.480
5	-0.616	-0.256	0.131	23,430	5.300	5.500	5.400	-7.266	7.266
6	-0.553	-0.202	0.161	23,430	5.234	5.326	5.280	-5.869	5.869
7	-0.486	-0.148	0.216	23,430	5.138	5.336	5.237	-4.332	4.332
8	-0.514	-0.158	0.210	23,430	5.274	5.359	5.316	-4.551	4.551
9	-0.469	-0.100	0.271	23,430	5.366	5.383	5.374	-2.851	2.851
10	-0.521	-0.141	0.257	23,430	5.452	5.575	5.514	-3.903	3.903
11	-0.574	-0.187	0.228	23,430	5.496	5.691	5.593	-5.115	5.115
12	-0.662	-0.247	0.169	23,430	5.692	5.699	5.695	-6.642	6.642
13	-0.665	-0.258	0.155	23,430	5.637	5.677	5.657	-6.972	6.972
14	-0.704	-0.277	0.148	23,430	5.775	5.764	5.770	-7.349	7.349
15	-0.749	-0.298	0.146	23,430	5.936	5.890	5.913	-7.711	7.711

Source: Own work.

Appendix 8: *One-sided t-test, all industries/decreasing rates, Europe*

T-test (Europe - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	3,680	0.000	0.000	0.000	0.000	0.000
-4	-0.165	-0.039	0.087	3,680	1.978	1.970	1.974	-1.184	1.184
-3	-0.254	-0.079	0.091	3,680	2.327	2.292	2.309	-2.073	2.073
-2	-0.354	-0.139	0.058	3,680	2.584	2.468	2.526	-3.328	3.328
-1	-0.370	-0.120	0.126	3,680	2.782	2.755	2.769	-2.623	2.623
0	-0.412	-0.126	0.154	3,680	2.978	2.943	2.960	-2.577	2.577
1	-0.455	-0.132	0.182	3,680	3.162	3.119	3.140	-2.546	2.546
2	-0.504	-0.134	0.216	3,680	3.386	3.292	3.339	-2.429	2.429
3	-0.447	-0.057	0.316	3,680	3.471	3.398	3.434	-1.013	1.013
4	-0.417	-0.022	0.352	3,680	3.499	3.401	3.450	-0.384	0.384
5	-0.501	-0.068	0.352	3,680	3.662	3.604	3.633	-1.137	1.137

T-test (Europe - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	7,360	0.000	0.000	0.000	0.000	0.000
-9	-0.202	-0.085	0.035	7,360	2.259	2.291	2.275	-3.206	3.206
-8	-0.350	-0.158	0.030	7,360	2.905	2.863	2.884	-4.691	4.691
-7	-0.418	-0.181	0.050	7,360	3.218	3.185	3.201	-4.861	4.861
-6	-0.530	-0.233	0.068	7,360	3.607	3.629	3.618	-5.525	5.525
-5	-0.648	-0.309	0.012	7,360	3.854	3.746	3.800	-6.973	6.973
-4	-0.723	-0.349	0.006	7,360	4.046	3.946	3.996	-7.501	7.501
-3	-0.807	-0.399	-0.027	7,360	4.228	4.035	4.131	-8.285	8.285
-2	-0.870	-0.456	-0.066	7,360	4.258	4.131	4.194	-9.332	9.332
-1	-0.891	-0.443	-0.028	7,360	4.424	4.266	4.345	-8.757	8.757
0	-0.916	-0.461	-0.028	7,360	4.459	4.358	4.408	-8.980	8.980
1	-0.941	-0.479	-0.027	7,360	4.494	4.449	4.471	-9.199	9.199
2	-1.020	-0.490	0.017	7,360	4.817	4.709	4.763	-8.825	8.825
3	-0.923	-0.412	0.100	7,360	4.728	4.736	4.732	-7.472	7.472
4	-0.880	-0.377	0.135	7,360	4.694	4.730	4.712	-6.857	6.857
5	-0.938	-0.422	0.092	7,360	4.750	4.745	4.748	-7.632	7.632
6	-0.999	-0.462	0.091	7,360	4.846	4.918	4.882	-8.118	8.118
7	-1.019	-0.504	0.047	7,360	4.745	4.911	4.828	-8.961	8.961
8	-1.070	-0.517	0.030	7,360	4.917	4.895	4.906	-9.045	9.045
9	-1.112	-0.563	-0.006	7,360	4.902	4.939	4.920	-9.818	9.818
10	-1.136	-0.556	0.032	7,360	5.038	5.075	5.057	-9.436	9.436

T-test (Europe - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	11,040	0.000	0.000	0.000	0.000	0.000
-14	-0.138	0.012	0.153	11,040	2.842	2.746	2.794	0.461	0.461
-13	-0.191	0.107	0.471	11,040	4.000	4.415	4.208	2.677	2.677
-12	-0.341	0.105	0.745	11,040	4.893	5.857	5.375	2.054	2.054
-11	-0.213	0.175	0.631	11,040	4.560	4.943	4.752	3.864	3.864
-10	-0.258	0.161	0.617	11,040	4.740	4.939	4.840	3.504	3.504
-9	-0.342	0.081	0.536	11,040	4.763	4.937	4.850	1.761	1.761
-8	-0.373	0.007	0.404	11,040	4.516	4.609	4.563	0.167	0.167
-7	-0.400	-0.021	0.379	11,040	4.510	4.630	4.570	-0.482	0.482
-6	-0.482	-0.075	0.367	11,040	4.668	4.872	4.770	-1.661	1.661
-5	-0.589	-0.149	0.323	11,040	4.858	5.031	4.944	-3.164	3.164
-4	-0.661	-0.193	0.319	11,040	5.008	5.239	5.123	-3.966	3.966
-3	-0.744	-0.244	0.281	11,040	5.177	5.303	5.240	-4.892	4.892
-2	-0.816	-0.307	0.207	11,040	5.222	5.250	5.236	-6.159	6.159
-1	-0.810	-0.288	0.231	11,040	5.286	5.276	5.281	-5.738	5.738
0	-0.837	-0.308	0.220	11,040	5.329	5.321	5.325	-6.069	6.069
1	-0.865	-0.327	0.210	11,040	5.372	5.365	5.368	-6.395	6.395
2	-0.901	-0.334	0.241	11,040	5.515	5.550	5.532	-6.341	6.341
3	-0.823	-0.259	0.335	11,040	5.499	5.640	5.569	-4.880	4.880
4	-0.795	-0.223	0.378	11,040	5.539	5.673	5.606	-4.173	4.173
5	-0.857	-0.265	0.362	11,040	5.631	5.798	5.714	-4.880	4.880
6	-0.917	-0.303	0.341	11,040	5.737	5.876	5.806	-5.476	5.476
7	-0.947	-0.342	0.298	11,040	5.693	5.859	5.776	-6.220	6.220
8	-0.935	-0.352	0.278	11,040	5.592	5.809	5.701	-6.486	6.486
9	-0.957	-0.400	0.205	11,040	5.467	5.692	5.579	-7.525	7.525
10	-1.003	-0.391	0.273	11,040	5.731	5.963	5.847	-7.021	7.021
11	-1.114	-0.462	0.243	11,040	5.910	6.151	6.031	-8.056	8.056
12	-1.058	-0.382	0.375	11,040	6.020	6.369	6.195	-6.475	6.475
13	-1.040	-0.253	0.645	11,040	6.497	6.939	6.718	-3.958	3.958
14	-1.017	-0.165	0.776	11,040	6.758	7.103	6.931	-2.503	2.503
15	-0.969	-0.186	0.644	11,040	6.477	6.670	6.574	-2.977	2.977

Source: Own work.

Appendix 9: *One-sided t-test, all industries/decreasing rates, the US*

T-test (US - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	3,410	0.000	0.000	0.000	0.000	0.000
-4	-0.226	-0.071	0.082	3,410	2.151	2.139	2.145	-1.935	1.935
-3	-0.292	-0.091	0.112	3,410	2.448	2.457	2.452	-2.157	2.157
-2	-0.272	-0.034	0.195	3,410	2.660	2.615	2.637	-0.756	0.756
-1	-0.345	-0.032	0.282	3,410	3.055	3.058	3.056	-0.614	0.614
0	-0.393	-0.036	0.322	3,410	3.262	3.266	3.264	-0.642	0.642
1	-0.441	-0.040	0.363	3,410	3.457	3.462	3.460	-0.669	0.669
2	-0.556	-0.098	0.354	3,410	3.693	3.673	3.683	-1.560	1.560
3	-0.462	-0.017	0.402	3,410	3.640	3.533	3.587	-0.279	0.279
4	-0.590	-0.112	0.341	3,410	3.776	3.674	3.725	-1.749	1.749
5	-0.774	-0.233	0.254	3,410	4.015	3.807	3.911	-3.474	3.474
T-test (US - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	6,820	0.000	0.000	0.000	0.000	0.000
-9	-0.159	-0.032	0.099	6,820	2.308	2.350	2.329	-1.152	1.152
-8	-0.197	0.015	0.216	6,820	2.990	2.912	2.951	0.425	0.425
-7	-0.246	0.005	0.247	6,820	3.252	3.194	3.223	0.127	0.127
-6	-0.303	-0.004	0.294	6,820	3.550	3.544	3.547	-0.086	0.086
-5	-0.427	-0.084	0.251	6,820	3.801	3.761	3.781	-1.842	1.842
-4	-0.508	-0.157	0.195	6,820	3.845	3.850	3.848	-3.365	3.365
-3	-0.561	-0.177	0.196	6,820	4.025	3.965	3.995	-3.657	3.657
-2	-0.501	-0.119	0.250	6,820	4.009	3.944	3.977	-2.478	2.478
-1	-0.546	-0.116	0.312	6,820	4.254	4.246	4.250	-2.259	2.259
0	-0.606	-0.119	0.347	6,820	4.529	4.432	4.481	-2.193	2.193
1	-0.666	-0.122	0.383	6,820	4.789	4.611	4.700	-2.139	2.139
2	-0.807	-0.181	0.422	6,820	5.135	5.041	5.088	-2.934	2.934
3	-0.680	-0.098	0.443	6,820	4.953	4.774	4.863	-1.665	1.665
4	-0.787	-0.191	0.397	6,820	5.010	4.978	4.994	-3.155	3.155
5	-0.956	-0.313	0.297	6,820	5.206	5.069	5.138	-5.025	5.025
6	-0.861	-0.255	0.346	6,820	5.053	5.034	5.043	-4.177	4.177
7	-0.825	-0.210	0.419	6,820	5.089	5.145	5.117	-3.386	3.386
8	-0.813	-0.216	0.380	6,820	5.017	5.009	5.013	-3.558	3.558
9	-0.825	-0.168	0.435	6,820	5.259	5.041	5.150	-2.701	2.701
10	-0.970	-0.302	0.352	6,820	5.304	5.249	5.276	-4.724	4.724
T-test (US - all industries/only decreasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	10,280	0.000	0.000	0.000	0.000	0.000
-14	-0.165	0.023	0.221	10,280	3.119	3.200	3.159	0.738	0.738
-13	-0.180	0.030	0.228	10,280	3.295	3.203	3.249	0.935	0.935
-12	-0.396	-0.146	0.118	10,280	3.595	3.698	3.647	-4.066	4.066
-11	-0.460	-0.186	0.116	10,280	3.770	3.949	3.860	-4.874	4.874
-10	-0.535	-0.221	0.142	10,280	4.027	4.336	4.182	-5.362	5.362
-9	-0.619	-0.257	0.138	10,280	4.328	4.520	4.424	-5.886	5.886
-8	-0.592	-0.211	0.198	10,280	4.438	4.600	4.519	-4.742	4.742
-7	-0.622	-0.223	0.210	10,280	4.542	4.736	4.639	-4.878	4.878
-6	-0.678	-0.236	0.235	10,280	4.785	4.936	4.860	-4.919	4.919
-5	-0.796	-0.319	0.210	10,280	4.969	5.228	5.098	-6.335	6.335
-4	-0.842	-0.394	0.114	10,280	4.811	5.129	4.970	-8.047	8.047
-3	-0.905	-0.418	0.123	10,280	5.020	5.292	5.156	-8.226	8.226
-2	-0.846	-0.361	0.181	10,280	5.010	5.293	5.152	-7.104	7.104
-1	-0.855	-0.359	0.195	10,280	5.065	5.352	5.208	-6.985	6.985
0	-0.895	-0.363	0.211	10,280	5.248	5.449	5.348	-6.874	6.874
1	-0.935	-0.366	0.228	10,280	5.424	5.544	5.484	-6.772	6.772
2	-1.063	-0.428	0.226	10,280	5.727	5.819	5.773	-7.526	7.526
3	-0.954	-0.347	0.280	10,280	5.603	5.697	5.650	-6.236	6.236
4	-1.047	-0.442	0.201	10,280	5.593	5.768	5.680	-7.892	7.892
5	-1.218	-0.569	0.096	10,280	5.796	5.866	5.831	-9.890	9.890
6	-1.118	-0.514	0.157	10,280	5.591	5.889	5.740	-9.075	9.075
7	-1.077	-0.470	0.216	10,280	5.605	5.957	5.781	-8.236	8.236
8	-1.077	-0.478	0.213	10,280	5.566	5.979	5.773	-8.402	8.402
9	-1.066	-0.433	0.230	10,280	5.721	5.860	5.790	-7.590	7.590
10	-1.220	-0.571	0.157	10,280	5.793	6.138	5.965	-9.706	9.706
11	-1.216	-0.600	0.162	10,280	5.647	6.276	5.962	-10.204	10.204
12	-1.335	-0.653	0.125	10,280	5.937	6.345	6.141	-10.785	10.785
13	-1.374	-0.681	0.108	10,280	5.991	6.389	6.190	-11.150	11.150
14	-1.409	-0.724	0.070	10,280	5.954	6.408	6.181	-11.868	11.868
15	-1.430	-0.734	0.018	10,280	6.000	6.237	6.119	-12.170	12.170

Source: Own work.

Appendix 10: *One-sided t-test, all industries/increasing rates, Europe*

T-test (Europe - all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	4,480	0.000	0.000	0.000	0.000	0.000
-4	-0.084	0.008	0.101	4,480	1.776	1.781	1.778	0.315	0.315
-3	-0.069	0.070	0.214	4,480	2.179	2.215	2.197	2.139	2.139
-2	-0.106	0.093	0.299	4,480	2.603	2.651	2.627	2.367	2.367
-1	-0.165	0.049	0.270	4,480	2.704	2.746	2.725	1.203	1.203
0	-0.180	0.030	0.255	4,480	2.679	2.767	2.723	0.746	0.746
1	-0.194	0.012	0.239	4,480	2.652	2.788	2.720	0.288	0.288
2	-0.178	0.070	0.341	4,480	2.911	3.040	2.976	1.583	1.583
3	-0.213	0.064	0.352	4,480	3.077	3.136	3.107	1.382	1.382
4	-0.250	0.041	0.340	4,480	3.154	3.196	3.175	0.869	0.869
5	-0.231	0.074	0.383	4,480	3.227	3.247	3.237	1.540	1.540

T-test (Europe - all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	8,960	0.000	0.000	0.000	0.000	0.000
-9	-0.100	-0.024	0.057	8,960	1.920	1.970	1.945	-1.157	1.157
-8	-0.165	-0.048	0.087	8,960	2.380	2.549	2.464	-1.832	1.832
-7	-0.226	-0.079	0.073	8,960	2.665	2.709	2.687	-2.789	2.789
-6	-0.328	-0.135	0.057	8,960	3.046	3.046	3.046	-4.206	4.206
-5	-0.307	-0.096	0.118	8,960	3.191	3.219	3.205	-2.846	2.846
-4	-0.307	-0.089	0.133	8,960	3.248	3.273	3.260	-2.573	2.573
-3	-0.278	-0.027	0.207	8,960	3.483	3.367	3.425	-0.754	0.754
-2	-0.300	-0.005	0.269	8,960	3.775	3.640	3.707	-0.137	0.137
-1	-0.356	-0.050	0.248	8,960	3.847	3.796	3.822	-1.238	1.238
0	-0.378	-0.069	0.233	8,960	3.865	3.821	3.843	-1.698	1.698
1	-0.400	-0.088	0.218	8,960	3.884	3.846	3.865	-2.152	2.152
2	-0.392	-0.030	0.308	8,960	4.180	4.040	4.110	-0.687	0.687
3	-0.406	-0.037	0.325	8,960	4.225	4.182	4.204	-0.828	0.828
4	-0.433	-0.060	0.309	8,960	4.245	4.225	4.235	-1.349	1.349
5	-0.396	-0.028	0.331	8,960	4.219	4.162	4.191	-0.626	0.626
6	-0.384	0.020	0.400	8,960	4.414	4.286	4.350	0.434	0.434
7	-0.340	0.054	0.442	8,960	4.358	4.331	4.344	1.167	1.167
8	-0.290	0.113	0.502	8,960	4.412	4.337	4.374	2.445	2.445
9	-0.292	0.120	0.527	8,960	4.457	4.432	4.444	2.551	2.551
10	-0.308	0.136	0.571	8,960	4.627	4.586	4.606	2.787	2.787

T-test (Europe -all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	13,440	0.000	0.000	0.000	0.000	0.000
-14	-0.093	-0.026	0.045	13,440	1.990	2.046	2.018	-1.497	1.497
-13	-0.199	-0.075	0.040	13,440	2.706	2.610	2.658	-3.283	3.283
-12	-0.270	-0.115	0.029	13,440	3.027	2.914	2.970	-4.486	4.486
-11	-0.284	-0.104	0.075	13,440	3.266	3.257	3.261	-3.692	3.692
-10	-0.343	-0.143	0.059	13,440	3.437	3.461	3.449	-4.822	4.822
-9	-0.406	-0.166	0.085	13,440	3.768	3.850	3.809	-5.055	5.055
-8	-0.451	-0.189	0.072	13,440	3.937	3.930	3.933	-5.581	5.581
-7	-0.496	-0.222	0.050	13,440	4.024	4.014	4.019	-6.407	6.407
-6	-0.588	-0.280	0.036	13,440	4.271	4.320	4.296	-7.557	7.557
-5	-0.541	-0.241	0.087	13,440	4.214	4.406	4.310	-6.483	6.483
-4	-0.544	-0.234	0.090	13,440	4.282	4.378	4.330	-6.270	6.270
-3	-0.491	-0.173	0.160	13,440	4.337	4.440	4.388	-4.575	4.575
-2	-0.482	-0.152	0.213	13,440	4.423	4.644	4.534	-3.877	3.877
-1	-0.545	-0.198	0.175	13,440	4.534	4.694	4.614	-4.971	4.971
0	-0.577	-0.218	0.152	13,440	4.607	4.678	4.643	-5.437	5.437
1	-0.608	-0.238	0.130	13,440	4.679	4.663	4.671	-5.899	5.899
2	-0.556	-0.179	0.224	13,440	4.722	4.884	4.803	-4.322	4.322
3	-0.601	-0.187	0.256	13,440	4.950	5.118	5.034	-4.295	4.295
4	-0.617	-0.210	0.233	13,440	4.904	5.120	5.012	-4.864	4.864
5	-0.588	-0.178	0.259	13,440	4.926	5.086	5.006	-4.126	4.126
6	-0.557	-0.130	0.321	13,440	5.028	5.162	5.095	-2.953	2.953
7	-0.526	-0.096	0.354	13,440	5.044	5.159	5.101	-2.175	2.175
8	-0.484	-0.038	0.422	13,440	5.140	5.211	5.176	-0.841	0.841
9	-0.484	-0.031	0.465	13,440	5.174	5.415	5.294	-0.676	0.676
10	-0.477	-0.015	0.463	13,440	5.226	5.315	5.271	-0.329	0.329
11	-0.504	0.001	0.507	13,440	5.469	5.468	5.468	0.024	0.024
12	-0.443	0.063	0.595	13,440	5.475	5.609	5.542	1.326	1.326
13	-0.458	0.048	0.598	13,440	5.470	5.706	5.588	0.991	0.991
14	-0.481	0.051	0.586	13,440	5.607	5.629	5.618	1.047	1.047
15	-0.503	0.038	0.591	13,440	5.658	5.719	5.689	0.778	0.778

Source: Own work.

Appendix 11: *One-sided t-test, all industries/increasing rates, the US*

T-test (US - all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-5	0.000	0.000	0.000	4,400	0.000	0.000	0.000	0.000	0.000
-4	-0.073	0.016	0.112	4,400	1.740	1.804	1.772	0.606	0.606
-3	-0.120	-0.007	0.116	4,400	1.956	2.038	1.997	-0.234	0.234
-2	-0.187	-0.046	0.102	4,400	2.187	2.235	2.211	-1.367	1.367
-1	-0.191	-0.043	0.121	4,400	2.243	2.351	2.297	-1.233	1.233
0	-0.394	-0.067	0.292	4,400	3.330	3.484	3.407	-1.300	1.300
1	-0.203	-0.024	0.171	4,400	2.461	2.571	2.516	-0.635	0.635
2	-0.271	-0.076	0.128	4,400	2.571	2.625	2.598	-1.935	1.935
3	-0.335	-0.121	0.109	4,400	2.686	2.791	2.738	-2.939	2.939
4	-0.341	-0.105	0.134	4,400	2.827	2.841	2.834	-2.450	2.450
5	-0.399	-0.142	0.107	4,400	2.950	2.903	2.927	-3.221	3.221
T-test (US - all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-10	0.000	0.000	0.000	8,800	0.000	0.000	0.000	0.000	0.000
-9	-0.064	0.026	0.111	8,800	2.072	2.023	2.047	1.185	1.185
-8	-0.084	0.026	0.129	8,800	2.292	2.226	2.259	1.064	1.064
-7	-0.121	0.000	0.124	8,800	2.402	2.434	2.418	-0.006	0.006
-6	-0.142	0.007	0.154	8,800	2.673	2.655	2.664	0.250	0.250
-5	-0.061	0.114	0.298	8,800	2.894	2.972	2.933	3.635	3.635
-4	-0.073	0.127	0.333	8,800	3.098	3.142	3.120	3.826	3.826
-3	-0.102	0.106	0.307	8,800	3.155	3.099	3.127	3.176	3.176
-2	-0.153	0.063	0.291	8,800	3.217	3.297	3.257	1.826	1.826
-1	-0.165	0.063	0.297	8,800	3.306	3.346	3.326	1.779	1.779
0	-0.168	0.078	0.318	8,800	3.427	3.391	3.409	2.138	2.138
1	-0.170	0.092	0.339	8,800	3.544	3.435	3.489	2.482	2.482
2	-0.216	0.048	0.320	8,800	3.554	3.607	3.581	1.267	1.267
3	-0.257	0.009	0.288	8,800	3.569	3.654	3.611	0.229	0.229
4	-0.262	0.022	0.335	8,800	3.692	3.871	3.781	0.556	0.556
5	-0.334	-0.008	0.312	8,800	3.952	3.910	3.931	-0.190	0.190
6	-0.265	0.053	0.376	8,800	3.900	3.936	3.918	1.263	1.263
7	-0.224	0.121	0.449	8,800	4.067	3.958	4.013	2.840	2.840
8	-0.236	0.119	0.477	8,800	4.122	4.142	4.132	2.693	2.693
9	-0.174	0.197	0.584	8,800	4.211	4.302	4.256	4.339	4.339
10	-0.150	0.240	0.633	8,800	4.320	4.334	4.327	5.211	5.211
T-test (US - all industries/only increasing rates)									
tails	**2.5%**	**Mean**	**97.5%**	**sample size n**	**SD_lower**	**SD_upper**	**SD_average**	**t value**	**abs value**
-15	0.000	0.000	0.000	13,200	0.000	0.000	0.000	0.000	0.000
-14	-0.102	-0.021	0.061	13,200	2.171	2.198	2.184	-1.122	1.122
-13	-0.120	-0.009	0.102	13,200	2.546	2.559	2.553	-0.421	0.421
-12	-0.126	0.008	0.146	13,200	2.811	2.835	2.823	0.343	0.343
-11	-0.147	0.031	0.209	13,200	3.228	3.230	3.229	1.094	1.094
-10	-0.179	0.012	0.192	13,200	3.350	3.252	3.301	0.419	0.419
-9	-0.185	0.037	0.253	13,200	3.612	3.554	3.583	1.195	1.195
-8	-0.198	0.034	0.271	13,200	3.685	3.728	3.706	1.056	1.056
-7	-0.220	0.004	0.232	13,200	3.624	3.650	3.637	0.138	0.138
-6	-0.233	0.007	0.250	13,200	3.754	3.773	3.764	0.215	0.215
-5	-0.143	0.113	0.371	13,200	3.872	3.891	3.882	3.345	3.345
-4	-0.133	0.128	0.391	13,200	3.915	3.927	3.921	3.763	3.763
-3	-0.178	0.104	0.401	13,200	4.066	4.174	4.120	2.890	2.890
-2	-0.236	0.057	0.369	13,200	4.147	4.274	4.211	1.560	1.560
-1	-0.243	0.056	0.370	13,200	4.189	4.287	4.238	1.520	1.520
0	-0.238	0.069	0.390	13,200	4.242	4.338	4.290	1.855	1.855
1	-0.232	0.082	0.411	13,200	4.294	4.387	4.341	2.183	2.183
2	-0.297	0.037	0.389	13,200	4.424	4.544	4.484	0.952	0.952
3	-0.336	-0.005	0.365	13,200	4.403	4.660	4.532	-0.136	0.136
4	-0.348	0.005	0.382	13,200	4.550	4.703	4.627	0.116	0.116
5	-0.389	-0.029	0.357	13,200	4.590	4.759	4.674	-0.717	0.717
6	-0.352	0.028	0.416	13,200	4.722	4.767	4.745	0.686	0.686
7	-0.285	0.093	0.506	13,200	4.708	4.921	4.814	2.226	2.226
8	-0.287	0.088	0.505	13,200	4.686	4.946	4.816	2.099	2.099
9	-0.238	0.163	0.609	13,200	4.847	5.113	4.980	3.764	3.764
10	-0.226	0.203	0.659	13,200	5.016	5.169	5.092	4.582	4.582
11	-0.286	0.139	0.620	13,200	4.993	5.308	5.151	3.107	3.107
12	-0.354	0.080	0.578	13,200	5.042	5.402	5.222	1.756	1.756
13	-0.368	0.087	0.589	13,200	5.166	5.426	5.296	1.884	1.884
14	-0.389	0.092	0.624	13,200	5.307	5.588	5.448	1.930	1.930
15	-0.464	0.060	0.625	13,200	5.544	5.757	5.650	1.219	1.219

Source: Own work.

Appendix 12: *One-sided t-test, both markets (the first sample)*

T test (Europe - three industries/all events)
Industries: oil and gas, basic resources, food and beverage

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	1,530	0.000	0.000	0.000	0.000	0.000
-4	-0.278	-0.069	0.141	1,530	2.045	2.045	2.045	-1.312	1.312
-3	-0.175	0.115	0.399	1,530	2.405	2.381	2.393	1.879	1.879
-2	-0.332	0.076	0.457	1,530	2.855	2.756	2.806	1.066	1.066
-1	-0.543	-0.111	0.343	1,530	2.935	3.010	2.972	-1.463	1.463
0	-0.595	-0.145	0.323	1,530	2.997	3.056	3.027	-1.871	1.871
1	-0.647	-0.178	0.304	1,530	3.059	3.101	3.080	-2.265	2.265
2	-0.391	0.141	0.688	1,530	3.257	3.303	3.280	1.682	1.682
3	-0.289	0.298	0.872	1,530	3.422	3.385	3.403	3.421	3.421
4	-0.408	0.202	0.835	1,530	3.492	3.552	3.522	2.248	2.248
5	-0.832	-0.175	0.456	1,530	3.620	3.549	3.585	-1.913	1.913

T test (Europe - three industries/only decreasing rates)
Industries: oil and gas, basic resources, food and beverage

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	690	0.000	0.000	0.000	0.000	0.000
-4	-0.507	-0.120	0.250	690	2.278	2.226	2.252	-1.401	1.401
-3	-0.533	-0.088	0.340	690	2.443	2.396	2.419	-0.955	0.955
-2	-0.664	-0.110	0.373	690	2.725	2.543	2.634	-1.094	1.094
-1	-0.827	-0.153	0.492	690	3.004	2.941	2.973	-1.356	1.356
0	-0.912	-0.236	0.397	690	3.011	2.912	2.962	-2.092	2.092
1	-0.998	-0.318	0.302	690	3.018	2.882	2.950	-2.834	2.834
2	-0.862	-0.162	0.534	690	3.064	3.053	3.058	-1.389	1.389
3	-0.751	0.028	0.819	690	3.230	3.256	3.243	0.223	0.223
4	-1.020	-0.143	0.704	690	3.429	3.369	3.399	-1.104	1.104
5	-1.683	-0.710	0.220	690	3.611	3.531	3.571	-5.225	5.225

T test (Europe - three industries/only increasing rates)
Industries: oil and gas, basic resources, food and beverage

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	840	0.000	0.000	0.000	0.000	0.000
-4	-0.077	0.155	0.378	840	1.855	1.816	1.835	2.449	2.449
-3	0.077	0.423	0.792	840	2.263	2.334	2.299	5.337	5.337
-2	-0.141	0.419	1.068	840	2.876	3.100	2.988	4.061	4.061
-1	-0.424	0.199	0.849	840	3.036	3.099	3.067	1.883	1.883
0	-0.377	0.246	0.888	840	3.036	3.080	3.058	2.332	2.332
1	-0.330	0.293	0.927	840	3.036	3.061	3.049	2.783	2.783
2	-0.080	0.731	1.549	840	3.461	3.479	3.470	6.101	6.101
3	-0.219	0.694	1.558	840	3.675	3.576	3.625	5.547	5.547
4	-0.342	0.579	1.506	840	3.692	3.702	3.697	4.543	4.543
5	-0.520	0.420	1.289	840	3.727	3.585	3.656	3.327	3.327

T test (US - three industries/all events)
Industries: energy sector, consumer staples, consumer disc.

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	2,130	0.000	0.000	0.000	0.000	0.000
-4	-0.182	-0.046	0.096	2,130	1.790	1.829	1.809	-1.170	1.170
-3	-0.391	-0.175	0.047	2,130	2.257	2.283	2.270	-3.553	3.553
-2	-0.370	-0.131	0.119	2,130	2.372	2.429	2.401	-2.521	2.521
-1	-0.512	-0.211	0.110	2,130	2.665	2.748	2.707	-3.590	3.590
0	-0.607	-0.255	0.121	2,130	2.881	2.975	2.928	-4.018	4.018
1	-0.703	-0.299	0.131	2,130	3.082	3.185	3.133	-4.408	4.408
2	-0.924	-0.454	0.014	2,130	3.329	3.319	3.324	-6.298	6.298
3	-0.852	-0.404	0.029	2,130	3.247	3.195	3.221	-5.793	5.793
4	-1.030	-0.511	-0.031	2,130	3.496	3.359	3.428	-6.875	6.875
5	-1.204	-0.623	-0.121	2,130	3.700	3.436	3.568	-8.054	8.054

T test (US - three industries/only decreasing rates)
Industries: energy sector, consumer staples, consumer disc.

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	930	0.000	0.000	0.000	0.000	0.000
-4	-0.332	-0.066	0.214	930	2.034	2.087	2.060	-0.980	0.980
-3	-0.676	-0.299	0.106	930	2.423	2.509	2.466	-3.698	3.698
-2	-0.619	-0.239	0.162	930	2.433	2.498	2.466	-2.955	2.955
-1	-0.910	-0.375	0.223	930	2.885	3.050	2.968	-3.853	3.853
0	-1.133	-0.489	0.176	930	3.165	3.216	3.191	-4.673	4.673
1	-1.355	-0.603	0.129	930	3.422	3.374	3.398	-5.410	5.410
2	-1.725	-0.847	0.008	930	3.695	3.647	3.671	-7.039	7.039
3	-1.402	-0.651	0.146	930	3.419	3.522	3.470	-5.719	5.719
4	-1.863	-0.921	-0.044	930	3.828	3.695	3.761	-7.471	7.471
5	-2.020	-1.015	-0.055	930	3.954	3.864	3.909	-7.917	7.917

T test (US - three industries/only increasing rates)
Industries: energy sector, consumer staples, consumer disc.

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	1,200	0.000	0.000	0.000	0.000	0.000
-4	-0.180	-0.027	0.139	1,200	1.644	1.715	1.680	-0.562	0.562
-3	-0.348	-0.092	0.165	1,200	2.128	2.132	2.130	-1.495	1.495
-2	-0.397	-0.065	0.273	1,200	2.422	2.442	2.432	-0.922	0.922
-1	-0.472	-0.100	0.263	1,200	2.565	2.532	2.548	-1.353	1.353
0	-0.510	-0.090	0.313	1,200	2.725	2.667	2.696	-1.155	1.155
1	-0.548	-0.080	0.362	1,200	2.876	2.796	2.836	-0.979	0.979
2	-0.653	-0.171	0.265	1,200	2.921	2.774	2.847	-2.075	2.075
3	-0.765	-0.230	0.249	1,200	3.074	2.912	2.993	-2.667	2.667
4	-0.813	-0.215	0.313	1,200	3.249	3.057	3.153	-2.366	2.366
5	-0.983	-0.339	0.206	1,200	3.372	3.104	3.238	-3.630	3.630

Source: Own work.

Appendix 13: *One-sided t-test, both markets (the second sample)*

T test (Europe - three industries/all events)
Industries: banks, insurance, real estate

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	1,530	0.000	0.000	0.000	0.000	0.000
-4	-0.178	0.034	0.226	1,530	2.057	1.957	2.007	0.656	0.656
-3	-0.629	-0.308	-0.028	1,530	2.529	2.364	2.446	-4.927	4.927
-2	-0.798	-0.382	-0.017	1,530	2.881	2.699	2.790	-5.361	5.361
-1	-0.950	-0.520	-0.149	1,530	2.931	2.722	2.826	-7.197	7.197
0	-0.955	-0.506	-0.099	1,530	2.990	2.852	2.921	-6.781	6.781
1	-0.959	-0.493	-0.049	1,530	3.049	2.976	3.012	-6.399	6.399
2	-1.218	-0.679	-0.142	1,530	3.280	3.273	3.276	-8.108	8.108
3	-1.285	-0.719	-0.182	1,530	3.362	3.273	3.317	-8.473	8.473
4	-1.323	-0.760	-0.226	1,530	3.351	3.264	3.307	-8.991	8.991
5	-1.344	-0.696	-0.119	1,530	3.595	3.393	3.494	-7.793	7.793

T test (Europe - three industries/only decreasing rates)
Industries: banks, insurance, real estate

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	690	0.000	0.000	0.000	0.000	0.000
-4	-0.230	0.113	0.442	690	2.142	2.102	2.122	1.394	1.394
-3	-1.050	-0.493	0.013	690	2.734	2.605	2.669	-4.850	4.850
-2	-1.504	-0.785	-0.177	690	3.105	2.853	2.979	-6.918	6.918
-1	-1.649	-0.927	-0.228	690	3.112	3.059	3.086	-7.888	7.888
0	-1.720	-0.897	-0.131	690	3.321	3.203	3.262	-7.220	7.220
1	-1.790	-0.867	-0.034	690	3.518	3.341	3.429	-6.639	6.639
2	-2.107	-1.105	-0.174	690	3.664	3.533	3.598	-8.070	8.070
3	-2.097	-1.087	-0.102	690	3.679	3.633	3.656	-7.811	7.811
4	-2.157	-1.097	-0.126	690	3.770	3.608	3.689	-7.812	7.812
5	-2.105	-0.964	0.123	690	3.911	3.817	3.864	-6.554	6.554

T test (Europe - three industries/only increasing rates)
Industries: banks, insurance, real estate

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	840	0.000	0.000	0.000	0.000	0.000
-4	-0.331	-0.074	0.175	840	1.950	1.917	1.934	-1.109	1.109
-3	-0.467	-0.131	0.206	840	2.229	2.232	2.231	-1.698	1.698
-2	-0.539	-0.068	0.419	840	2.639	2.682	2.660	-0.737	0.737
-1	-0.689	-0.229	0.261	840	2.609	2.692	2.650	-2.504	2.504
0	-0.757	-0.260	0.266	840	2.711	2.788	2.750	-2.740	2.740
1	-0.825	-0.291	0.271	840	2.810	2.882	2.846	-2.964	2.964
2	-0.850	-0.261	0.385	840	2.952	3.091	3.021	-2.499	2.499
3	-0.898	-0.286	0.340	840	3.008	3.042	3.025	-2.737	2.737
4	-1.017	-0.354	0.330	840	3.132	3.180	3.156	-3.246	3.246
5	-1.043	-0.360	0.314	840	3.177	3.156	3.167	-3.293	3.293

T test (US - three industries/all events)
Industries: financials, real estates, industrials

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	2,130	0.000	0.000	0.000	0.000	0.000
-4	-0.233	-0.012	0.185	2,130	2.283	2.154	2.219	-0.244	0.244
-3	-0.124	0.052	0.225	2,130	2.039	2.014	2.027	1.193	1.193
-2	-0.346	-0.090	0.145	2,130	2.455	2.354	2.405	-1.734	1.734
-1	-0.193	0.077	0.344	2,130	2.523	2.508	2.515	1.415	1.415
0	-0.218	0.092	0.419	2,130	2.700	2.775	2.738	1.546	1.546
1	-0.243	0.106	0.493	2,130	2.867	3.019	2.943	1.667	1.667
2	-0.196	0.199	0.602	2,130	3.051	3.079	3.065	3.002	3.002
3	-0.390	0.008	0.396	2,130	3.061	3.024	3.043	0.120	0.120
4	-0.425	-0.002	0.424	2,130	3.154	3.166	3.160	-0.032	0.032
5	-0.579	-0.137	0.300	2,130	3.226	3.206	3.216	-1.964	1.964

T test (US - three industries/only decreasing rates)
Industries: financials, real estates, industrials

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	930	0.000	0.000	0.000	0.000	0.000
-4	-0.658	-0.117	0.261	930	2.900	2.426	2.663	-1.342	1.342
-3	-0.296	0.040	0.361	930	2.285	2.233	2.259	0.541	0.541
-2	-0.585	-0.070	0.365	930	2.830	2.603	2.717	-0.789	0.789
-1	-0.328	0.257	0.762	930	3.018	2.801	2.909	2.697	2.697
0	-0.424	0.254	0.894	930	3.249	3.156	3.203	2.420	2.420
1	-0.521	0.251	1.027	930	3.465	3.476	3.471	2.205	2.205
2	-0.213	0.555	1.432	930	3.457	3.695	3.576	4.731	4.731
3	-0.612	0.177	1.042	930	3.502	3.669	3.586	1.502	1.502
4	-0.697	0.177	1.115	930	3.688	3.820	3.754	1.438	1.438
5	-1.130	-0.154	0.755	930	3.897	3.761	3.829	-1.225	1.225

T test (US - three industries/only increasing rates)
Industries: financials, real estates, industrials

tails	2.5%	Mean	97.5%	sample size n	SD_lower	SD_upper	SD_average	t value	abs value
-5	0.000	0.000	0.000	1,200	0.000	0.000	0.000	0.000	0.000
-4	-0.127	0.054	0.232	1,200	1.786	1.773	1.780	1.049	1.049
-3	-0.145	0.062	0.252	1,200	1.911	1.835	1.873	1.138	1.138
-2	-0.401	-0.113	0.129	1,200	2.257	2.069	2.163	-1.816	1.816
-1	-0.351	-0.055	0.195	1,200	2.285	2.102	2.194	-0.872	0.872
0	-0.336	-0.024	0.251	1,200	2.349	2.207	2.278	-0.367	0.367
1	-0.322	0.007	0.308	1,200	2.412	2.307	2.360	0.103	0.103
2	-0.409	-0.040	0.326	1,200	2.553	2.546	2.550	-0.549	0.549
3	-0.525	-0.112	0.302	1,200	2.701	2.706	2.703	-1.437	1.437
4	-0.550	-0.131	0.277	1,200	2.721	2.687	2.704	-1.683	1.683
5	-0.596	-0.146	0.323	1,200	2.820	2.880	2.850	-1.772	1.772

Source: Own work.