Charles University

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

Coexceedance in financial markets of countries trying to join the European Union

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Declaration of Authorship

The author hereby declares that he compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

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Prague, July 14, 2018

Signature

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Abstract

This thesis analyses financial contagion between a reference EU market – Germany and markets of five countries which are actively seeking to become a part of European Union – Montenegro, Serbia, Turkey, Bosnia and Macedonia in the period of March 2006 to March 2018. We apply quantile regression framework to analyse contagion which we base on the occurrence and degree of coexceedances between the reference and analysed market. The results indicate that contagion between stock markets exists, however in different degree for each of the analysed markets. In addition we apply the regression framework specifically for period of financial crisis of 2008 to demonstrate that contagion is stronger during turbulent market periods.

JEL Classification	G01, G14, G15
Keywords	coexceedance, quantile regression, contagion, stock markets

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Abstrakt

Táto práca analyzuje finančnú nákazu medzi referenčným trhom EÚ - Nemeckom a trhmi piatich krajín, ktoré sa aktívne snažia stať súčasťou Európskej únie - Čiernej Hory, Srbska, Turecka, Bosny a Macedónska v období od marca 2006 do marca 2018. Aplikujeme kvantilovú regresiu na analýzu nákazy, ktorá sa zakladá na výskyte a stupni „coexceedances" medzi referenčným a analyzovaným trhom. Výsledky naznačujú, že existuje nákaza medzi akciovými trhmi, avšak v rôznom rozsahu pre každý z analyzovaných trhov. Okrem toho používame rámec kvantilovej regresie špeciálne pre obdobie finančnej krízy z roku 2008, aby sme preukázali, že nákaza je silnejšia počas turbulentných období na trhu.

Klasifikace	G01, G14, G15
Klíčová slova	metóda coexceedance, kvantilová regresia, nákaza, akciové trhy

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Acronyms

BELEX15	Belgrade Stock Exchange Index
BIST100	Instanbul Stock Exchange Index
BRENT	Crude oil that serves as a major benchmark price of oil from North Sea
DAX30	Frankfurt Stock Exchange Index
EU	European Union
EUR	Euro – currency of the European Monetary Union
MBI10	Macedonian Stock Exchange Index
MONEX20	Montenegro Stock Exchange Index
SASX10	Sarajevo Stock Exchange Index
USD	United States Dollar - currency

Master's Thesis Proposal

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Proposed Topic:

Coexceedance in financial markets of countries trying to join the European Union

Motivation:

The main motivation behind this thesis is to uncover the nature of financial contagion in countries that might be able to join the European Union in the near future. With them joining, their financial markets will become more interconnected with the financial markets of European Union countries and also with other countries because the investors will be more likely to participate in financial markets of these countries after joining the EU. If we find the channels for contagion spreading in these markets and what influences them, it can give us a clearer picture of how exactly these markets might influence the financial markets of other member states.

Hypotheses:

1. There exists a financial contagion between countries with the possibility to enter the EU
2. Contagion in financial markets of these countries is predictable
3. Coexceedance in financial markets of these countries is affected by stock returns volatility, interest and exchange rates

Methodology:

We will be examining the coexceedance in 5 countries that are the official candidates to become new members of the European Union – Turkey, Montenegro, Albania, Serbia and Macedonia with financial markets of EU market countries. We plan to collect the data directly from the financial markets of these countries. If available, we will be using daily closing data of stock, foreign exchange prices. As these countries do not have developed and very liquid financial markets, we might run into issues with the data collection and data credibility.

We will use the coexceedance methodology of Bae et al. (2003) to investigate integration between the financial markets of the candidate countries trying to join the European Union and financial markets in the EU. Authors define contagion as a joint occurrence of extreme (negative) returns within a group of markets. Bae et al. (2003) have defined a new approach; using coexceedance they studied financial contagion among stock markets. In order to examine the occurences and the extent of coexceedances in these markets we will use quantile regression framework. Frist step will be to obtain the volatility measures, using autoregressive model to decompose variance. After we will use the quantile regression framework to study return coexceedances to uncover the excess return co-movement. We plan to obtain results that will prove the existence of joint occurrences of extreme returns within the group of countries. We also aim to be able to explain these occurences and define what is affecting them.

Expected Contribution:

The current studies of this topic have provided us with empirical results about the nature of coexceedances in financial markets as a general. There are quite some studies about the nature of financial contagion in various regions of the world; however we plan to contribute with results about the extent of coexceedance in countries that might become a part of the European Union sometimes in the near future. By evaluating the extent and the determinants of contagion in these countries we can draw conclusion about the contagion spreading in these countries and about the possible effect of their coexceedance if they were to become more connected to the European Union financial markets.

Outline:

1. Introduction and motivation – introduction to the topic of coexceedance in financial markets, the motivation behind specifically using countries that are candidates for joining the EU
2. Literature Review – summarizing the previous studies done in about the topic of coexceedance
3. Data – methods of data collection, data used, brief description of the dataset
4. Methods – description of the econometric methods used in the paper
5. Results – introduction of the results obtained from the econometric models
6. Conclusion – conclusion of the findings obtained and proposed further use of these results

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1 Introduction

There are many economic questions that rise with a country being accepted to the European Union. The general public is mostly interested in the direct monetary influences a country brings to the table for the other member countries. This paper aims to focus on a different level of influence – on contagion.

The main motivation behind this thesis is to uncover the nature of financial contagion in countries that might be able to join the European Union in the near future. With them joining, their financial markets will become more interconnected with the financial markets of European Union countries and also with other countries because the investors will be more likely to participate in financial markets of these countries after joining the EU. If we find the channels for contagion spreading in these markets and what influences them, it can give us a clearer picture of how exactly these markets might influence the financial markets of other member states. This paper aims to provide an insight about how exactly are the markets of countries that are actively seeking to become new EU members interconnected with the currently most developed and strong market in the European Union – the German market. Germany, as the biggest economy, is also the biggest contributor to the budget of the European Union.

This paper works with 3 main hypotheses. First of all we will be trying to prove that there exists a financial contagion between countries with the possibility to enter the EU and the EU market which is represented by German Stock Exchange Market for the purposes of this study. Secondly, that contagion in financial markets of these countries is predictable and that we can draw conclusions about the future possible contagion effects from the region to the EU and the other way round. Lastly, we will be trying to prove that coexceedance in financial markets of these countries is affected by stock returns volatility and exchange rates by focusing on finding joint extreme return values in both the stock markets, which will be primarily represented by their main stock market indexes, and in the foreign exchange markets.

We will be examining the coexceedance in 5 countries that are the official candidates to become new members of the European Union – Turkey, Montenegro,

Bosnia, Serbia and Macedonia with financial market of the EU. We have collected the data directly from the financial markets of these countries. We will be using daily closing data of stock. As these countries do not have developed and very liquid financial markets, we have to take into account the possible issues with the data credibility. By evaluating the extent and the determinants of contagion in these countries by identifying their coexceedances of extreme value occurences in their markets and the markets of the European Union, we can draw conclusion about the contagion spreading in these countries. Secondly we can draw conclusions about the possible effect of the possible contagion routes if they were to become more connected to the European Union financial markets after they join the EU. We plan to obtain results that will prove the existence of joint occurrences of extreme returns within the group of countries. We also aim to be able to explain these occurrences and define what is affecting them.

The paper is structured as follows: Section 2 provides a thorough overview of the literature on the topic of financial contagion and coexceedances in both the pre-crisis and after-crisis periods; Section 3 describes the various data sets used for this study; Section 4 explains the methods and models used in this paper; Section 5 presents the readers with results of our study and Section 6 concludes this paper.

2 Literature Review

2.1 Before-crisis literature

The term coexceedance in financial markets or assets has only entered the economic world in the recent years. One of the earliest studies focused on the topic of measuring financial contagion with the use of exceedances was introduced by Bae, Karolyi and Stulz (2003). The authors arbitrarily define an extreme return, or exceedance, as one that lies either below (above) the 5th (95th) quantile of the marginal return distribution. Subsequently, they define coexceedance as joint occurrences of these extreme returns. The key hypothesis for Bae, et al. (2003) was the assumption that contagion occurs only with extreme returns present; essentially if there is contagion, small return shocks propagate differently from large-return shocks. The paper focused on investigate the propagation of large-return shocks within Latin America and Asia and across both regions. The authors chose to direct the focus of the study on counts of coincidences of extreme returns rather than on correlations of joint extreme returns. The base of the study lied in modeling the counts of joint occurrences of extreme returns using the multinomial logistic regression approach and using Monte Carlo simulation to calibrate the results for returns distributed as multivariate normal, Student's t and with GARCH effects. The results from both Asia and Latin America indicate that probability of the coexceedances is affected by exchange rate shocks to the region – extreme returns were reported more likely in the event of currency fall (rise), however it is not subject to the level of interest rates within the region. A crucial difference in the results was reported in the equality of probability of positive and negative return coexceedances - Asian market provides no evidence that coexceedance events are less likely for positive extreme returns than for negative extreme returns unlike the Latin American market in which coexceedances are more likely for negative extreme returns. Arguably the most important outcome of this study would be the contagion found between the regions. Authors conclude that contagion from Latin America to other regions of the world is more important than contagion from Asia and also that The United States is largely insulated from contagion from Asia.

A different method to testing the occurrence of contagion in a cluster of countries has been developed by Baur and Schulze (2005). Authors introduced a measure of degree of coexceedances in addition to only specifying the existence of coexceedances as Bae et al. (2003). Additionally, authors differ from the analysis of Bae et al. (2003) by modeling the computed coexceedances in every point of time t using the quantile regression model of Koenker and Bassett (1978) with the aim to analyze the behavior of extreme coexceedances for different regimes of coexceedances. Furthermore Baur and Schulze (2005) used the model to detect contagion among financial markets by also analyzing particular crisis periods. The authors argue that the main advantage of the quantile regression model lies in the possibility of analyzing the degree of coexceedances in addition to just the occurrence of coexceedances. A tremendous addition of this model comes from the conditional quantile estimates showing the evolution of coexceedances over time. The analysis of the regional results can be interpreted as uncertain with Baur and Schulze (2005) describing to find contagion in some cases and interdependence in other cases. Nevertheless, authors report findings of cross-regional coexceedances with evidence of contagion from Asia to Latin America and Europe but not to the United States, what remains in line with Bae et al. (2003) who conclude that the US market is insulated from Asian markets.

Christiansen and Ranaldo (2008) analyze the coexceedance that account for number of extreme returns on a given day in the new European Union member states' stock markets. Comparably to Bae et al. (2003) authors use the multinomial logit model to uncover the relation between the coexceedance variable and persistence, asset classes, and volatility. The primary aim of this study lays in illustrating whether and to what extent co-movements across national stock markets change after the EU enlargement. Contrary to previous literature the writers are not examining crisis periods thus not investigating contagion effects as such. However they argue that the model can act as a foundation for analyses in crisis periods, too. The data used in the study describe the integration between the stock markets in the 10 new EU member states from the former Communist countries in Eastern and Central Europe as well as the integration between the 14 old EU member states. The findings are in line with the initial hypothesis, the authors report to find co-movement between the old and new EU markets; with rising number of extreme negative returns in the old EU markets the

probability of many extreme negative returns in the new EU markets rises as well. Further findings are similar to those in the previous studies, when Christiansen and Ranaldo (2008) find that not only the stock returns in old EU markets but also currency returns have a positive effect on the likelihood of observing coexceedances in extreme returns in the new EU markets, and that interest rates are of no importance to this likelihood.

Overall, authors claim that empirical evidence clearly points to the fact that entering countries are more likely the victims of contagion from the markets they are joining. They argue that the downside of economic integration is the increased shock propagation across countries, after finding significant global linkages of new EU markets with stock markets in old EU countries.

Forbes and Rigobon (2002) provide a different view on the topic of contagion. Authors did not distinguish between contagion and interdependence. Their main aim was to investigate the channels of distribution of the negative shocks. The authors were relying on the analysis of the correlation coefficients during the crisis period. As the body of their study they examined cross-country stock market comovements to uncover if there exists contagion or just interdependence. Contagion was tested based on cross-market correlation coefficients, with the aim to show the tests to be biased and inaccurate due to heteroskedasticity. During more volatile periods of crisis the estimates of the correlation coefficient tend to be biased upwards and increased. This is due to cross market correlation coefficients being conditional on market volatility. Evidence of contagion is present if test are not adjusted for this bias, however we can specify and correct this bias under certain assumptions. After this correction is performed, estimates show a high level of market comovement during both turbulent as well as tranquil periods. Authors refer to this comovement as interdependence. This approach is however flawed since from all the conditions that need to be fulfilled it is often the case that at least one of them is violated.

Baig and Goldfajn (1999) test for evidence of contagion between the financial markets of Thailand, Malaysia, Indonesia, Korea, and the Philippines. The authors use correlations and vector autoregressions (VARs) to capture the extent of comovement in the markets during the crisis. They test for a significant increase in the correlations of the markets during the financial crisis period. In addition to previous analysis authors

also estimate the impact of own-country and cross-border news on the financial markets. To estimate the impulse responses to shock they apply above mentioned VAR methodology in each of the currency and stock markets. Later they perform test to see if the correlations in the various markets increase significantly during the crisis period in comparison to historical, "tranquil" period levels. This is in line of the previous literature and also with the analyses conducted by us. In additional the authors construct a set of dummy variables using daily news to capture the impact of own-country and cross-border news on the markets. Baig and Goldfajn (1999) find that correlations in currency and sovereign spreads increase significantly during the crisis period, however the equity market correlations offer mixed evidence. It is shown that after controlling for own country news and other fundamentals, there is evidence of cross-border contagion in the currency and equity markets.

2.2 After-crisis literature

One of the earliest articles published on the topic of financial market contagion published in 2011 titled “Global financial crisis, extreme interdependences, and contagion effects: The role of economic structure?” written by Aloui, Aissa and Nguyen is using a quite different method for modeling the joint occurrences of extreme values than the previously cited literature. The authors are using a set copula functions to illustrate the dynamic patterns of fat tails. Additionally, these functions also capture the linear and nonlinear interdependences that help model the degree of cross-market linkages. For the purposes of the study the authors have chosen to use daily returns from BRIC countries – Brazil, Russia, India, and China – and the US. As it was the case with previous literature, the results include strong evidence of time-varying dependence between the BRIC countries’ markets and the United States markets. These effects seem to be stronger for commodity-price dependent markets in these countries. The results report the dependence being highly persistent again for all markets and regardless of the current state of the market.

Thomadakis (2012) defines contagion within regions as the fraction of the coexceedances that cannot be explained by fundamentals (such as interest rate, bond yield or exchange rate) and contagion across regions of the European Area (EA) and

the US as the fraction of the coexceedance events in the EA that is left unexplained by its own covariates but that is explained by the exceedances from the US. The authors has applied a multinomial logistic regression model that is used frequently in the coexceedance literature on a sample of data of daily returns on 14 European stock markets for the period 2004-2012. Following the approach of Bae et al. (2003) and Christiansen and Ranaldo (2008) the author is aiming to model the number of extreme negative and positive returns within the EA occurring in more than one countries simultaneously. In contrast to other literature Thomadakis is using standardised residuals of a GARCH model to construct the coexceedances variables rather than using unconditional sample period returns. Additional to the model are fundamental variables; author used the variables proposed in Bae et al. (2003) like exchange rates (EUR/USD) and interest rates (EURIBOR) and also added the financial stock market return index (in European Monetary Union) and 10-year government bond yields (in EMU). To account for US fundamentals the study employs the exceedance variable depicting the number of days with extreme negative and positive percentile of the standardised residuals of the US industrial stock market distribution and the volatility of the US industrial stock market. Reported from the model is that the likelihood of observing negative coexceedances is negatively related to stock returns – the probability of experiencing negative returns is higher in four or more countries when the stock returns decrease. In line with previous literature is the finding that exchange rate and bond yield fail to explain the coexceedances within the European Area. Important finding of the study is that the model failed to prove the existence of contagion from the US to the European Area; author only reports interdependence between the markets. Essentially, contagion within the European Area has been proven by the model, but there are no statistically significant results that support the hypothesis that there is contagion from the US to the European markets.

Dimitriou, Kenourgios, and Simos (2013) employ a completely different methodology as the authors empirically investigate the contagion effects of the global financial crisis in a multivariate Fractionally Integrated Asymmetric Power ARCH (FIAPARCH) dynamic conditional correlation (DCC) framework during the period 1997–2012. As with majority of the studies in this field the focus is on five most important emerging equity markets, namely Brazil, Russia, India, China and South Africa (BRICS), as well as USA during different phases of the crisis. The authors use

a multi step process to determine the length and the phases of the crisis based on both an economic and a statistical approach. The empirical evidence from their study does not confirm a contagion effect for most BRICS during the early stages of the crisis, indicating signs of isolation or decoupling. After Lehman Brothers collapse however the linkages between markets emerged back, which according to the authors suggests a shift on investors' risk appetite. From 2009 onwards the correlations among BRICS and USA markets are increased. In total the authors do not find a patterns of contagion for the BRICSs' markets that could be attributed to their common trade.

Kenourgios, Samitas, and Paltalidis (2011) published paper Financial crises and stock market contagion in a multivariate time-varying asymmetric framework. Refering to paper by Forbes and Rigobon (2002) and their definition of contagion as "a significant increase in cross-market linkages after a shock to one country (or group of countries)", otherwise, a continued market correlation at high levels is considered to be "no contagion, only interdependence" they compare it to the traditional understanding of contagion as the spread of financial disturbances from one country to others. The authors are estimating a multivariate regime-switching copula model, which uses a GJR-GARCH-MA-t specification for the marginal distributions and the Gaussian copula for the joint distribution, in order to investigate financial contagion. Unlike the Forbes and Rigobon (2002) the authors can overcome the heteroskedasticity problem while also analysing correlation breakdowns and the second moment dynamics of financial time-series. This particular model enabled the authors to analyze the behavior among stock markets when at least one of them is in a financial crisis. The authors apply both methodologies to investigate contagion effect of five financial crises – namely the Asian crisis of 1997, the Russian Crisis in 1998, the Technology Bubble Collapse in 2000, the Brazilian Stock Market Crash in 1997 – 1998 and the Brazilian Crisis in 2002. Paper of Kenourgios, Samitas, and Paltalidis (2011) focuses mainly on four major emerging stock markets of Russia, Brazil, India and China (so called BRICS) and two major developed stock markets of United States and Unitek Kingdom. Authors test for the existence of stock market contagion – or peaks in correlation levels – by using Brazil as the crisis country for both Brazilian crises, Russia as the crisis country for the Russian default, U.S. and U.K. as the crises countries for the dot.com implosion, and India and China as the crises countries for the Asian crisis (due to their geographical position). Kenourgios, Samitas, and Paltalidis

(2011) estimate the correlations between the reference crisis country and the rest of the countries during both the stable and the crises periods. Estimation procedure is divided into sub-groups to compare the impact and the magnitude of spread of the crises for each individual country. Evidence from these analyses strongly confirm a contagion effect. Additionally to the finding of contagion, the authors have uncovered that an industry specific (industry induced) crises seem to have a larger impact than country specific (offset by country) crises. It is also confirmed that emerging BRIC countries are more prone to financial contagion than the strong developed markets. Results of the authors are in line with the previous literature as these results support the evidence of contagion being a behaviorally affected phenomenon rather than being affected by changes in macro-fundamentals. Authors also use conditional volatilities of equity indices, which is again in line with the literature on this subject. These volatilities exhibit widespread evidence of asymmetry, structural changes spread to other markets with a big order of magnitude, while increases in tail dependence imply that the probability of markets crashing together is higher during periods of financial turmoil. This evidence provides a very important point regarding financial policies. The evidence suggests that policy responses to a crisis are highly unlikely to prevent a crisis from spreading among countries since as mentioned above the correlation dynamics between markets are driven by behavioral reasons. In conlusion Kenourgios, Samitas, and Paltalidis (2011) provide a possible explanation for the contagion effect – the domino effect which was created by investors fleeing from many of the emerging markets after the series of crises in the late 1990s. The domino effect has caused significant changes in the emerging market's financial structures. Authors claim this paper to have important implications for international investors as the diversification sought by investing in multiple markets from different regional blocks is likely to be lower when it is most desirable. As a result, an investment strategy focused solely on international diversification seems not to work in practice during turmoil periods.

A paper titled Extreme Co-exceedance and Unexpected Volatility in Stock Markets:

Another Look at Financial Contagion by Lyocsa and Horvath from 2015 examines financial contagion from the US stock market to other major world stock markets, namely Japan (JP), Hong Kong (HK), Germany (DE), and United Kingdom (UK). Similarly to this study the authors chose to study the joint occurrences of extreme

returns using the most important stock markets indexes from these countries. Again similarly the authors in addition to stock market data use daily continuous returns of foreign exchange prices between the US dollar and corresponding local currency (USD/JPY, HKD/USD, EUR/USD, GBP/USD). The authors chose to also account for global factors in the study, for this purpose they decided to use continuous returns of STOXX Global 1800 (excluding North America) index denominated in USD and the implied stock market volatility measure, i.e. the VIX index. Another addition in the model is accounting for the changes in other asset classes; using the continuous daily return of the Europe Brent Spot Price (USD) and the Gold spot price (USD); and the accounting for the changes on the US corporate bond market using interest rate differentials. The period examined ranges from 1988 to 2014 what paints a great picture about the expected contagion both before and during the big stock market crisis that started in 2007. The main hypotheses of the authors is that higher unexpected volatility in the US stock market increases the coexceedance of extreme negative returns in the markets of studies countries. For their study the authors have chosen to begin by measuring market co-movement using the return coexceedance, an approach defined by Baur and Schulze (2005), to measure the unexpected volatility by a HAR model and to finally use quantile regression to study the coexceedances again in the likes of Baur and Schulze (2005). The authors have concluded that when stock market returns are negative higher unexpected volatility increases coexceedances, this is in line with the argument that there indeed is financial contagion from the US stock market to the other world stock markets and it has been observed in all countries. Eventually it is clear from the results that the financial contagion effect is stronger at lower quantiles – negative return coexceedances grow larger when a larger negative surprise occurs. Another important result from this paper is that positive shocks in the US market are propagated to other developed markets as well what only stresses the importance of examining positive and negative return coexceedances separately, to avoid biased evidences of contagion in cases where higher coexceedance of returns is driven by higher coexceedance in positive returns during periods of market uncertainty. As mentioned before, the authors included variables that accounted for other asset classes, however they have found out from the results that other asset classes do not have a systematic effect on extreme return coexceedances. Second part of results is characterized by the most intense period of the financial crisis occurring from September 2007 to March 2009. The authors created a special dummy variable for the

crisis period and found out that an increase in unexpected volatility, when stock markets are falling, increases coexceedances, which is in line with the results for the non-crisis periods. Interestingly, for some countries is the effect of increasing coexceedances less amplified during the financial crisis. Although the authors found some evidence that Japanese and Hong Kong stock markets become more sensitive to the unexpected negative events in the US market after 2007-2009 crisis, the results seem not to be affected by the time period of the data.

Horvath, Baumohl and Lyocsa (2016) have continued studying the subject of coexceedance, this time coexceedance from the U.S. stock market to six Central and Eastern European stock markets. The main novelty of this work is that it examines the period of the recent financial crisis when the developed countries were suffering from financial imbalances but the financial sectors in the Central and Eastern European remained largely stable. Again the authors have chosen to study data from time period of 1998 to 2014. Horvath, Baumohl and Lyocsa (2016) are defining financial contagion as "the joint occurrence of return coexceedances between two financial markets following an increase in unexpected volatility in one of the markets in the case where that market experiences negative returns". The primary hypothesis in the paper is that an increase in the unexpected volatility in U.S. stock market, at the time US stock market falls markedly, leads to extreme negative joint co-movements between the observed CEE markets and U.S. stock markets. The authors have chosen to use continuous returns of the S&P 500 stock market index to proxy the daily developments in the U.S. stock market. The development of the CEE emerging stock markets is measured via daily continuous returns of their market indices: CROBEX, PX, OMX Tallinn, BUX, WIG20, and BET, belonging to the CEE countries observed, namely the following countries: Croatia, the Czech Republic, Estonia, Hungary, Poland, and Romania. Again, as in the previous study the research includes variables that account for various global effects, namely the exchange rate between US dollar and the country currency, daily continuous returns of the STOXX Global 1800, the VIX and the Economic Policy Uncertainty Index, U.S. Treasury securities at 20-year constant maturity, Europe Brent Spot Price and Gold spot price. Important in this research is the methodology used. The authors decided to follow the framework of Bae et al. (2003)

for measuring coexceedance. The estimation has been composed of three steps. Firstly, return coexceedances are computed based on residuals from ARMAX(p,q)-EGARCH(r,f) models. Secondly, expected and unexpected volatility components are modeled based on RBHAR model (range-based heterogeneous autoregressive model). Finally, coexceedances are linked together with the decomposed volatility compontents within the quantile regression approach. The results provide the finding that joint extreme negative shocks are more common in the examined time period. The data show that the lowest joint extreme negative returns for all countries have been recorded in fall of 2008 which is the period corresponding to the peak of the financial crisis that has been set off in 2007. Findings are in line with the initial hypotheses when the study reports that unexpected events coupled with market declines (increased expected and unexpected volatility) increase the size of extreme market co-movements, suggesting that contagion from the U.S. market to the countries of CEE region has taken place. From the variables accounting for global events, only the STOXX 1800 index returns are statistically significant in all countries, all the other variables are only significant in a particular country. In line with previous literature are the results presented when the sample has been restricted to "good times" and "crisis" periods. Reported is that coexceedance persists also in the non-crisis periods, however it is stronger in the crisis period (2007-2009), with authors describing the results as that extreme negative coexceedance is higher for the same magnitude of "bad surprise" shock during the financial crisis as it would be if the crisis was not taking place.

A study conducted in 2014 by Dajcman takes a very centralized approach, since it is only examining the contagion between major European stock markets and Croatia in the period from end of 2003 until start of 2012 – in the period of big disturbances on the financial markets. Much like many authors Dajcman (2014) decided to use the framework and method of Bae et al. (2003) which incorporates the extreme value concept of exceedance returns and measures contagion based on joint occurrences of extreme stock market return. This study is only examining the joint occurrences of negative extreme values on the markets of Croatia and 10 other major stock markets in Europe, namely those of Austria, England, France, Germany, Greece, Hungary, Ireland, Italy, Russia and Spain. Author also decided to account for US stock market returns (proxied by the Dow Jones Industrial [DJI] returns), the conditional volatility of the average eurozone stock market returns (proxied by the EUROSTOXX50 returns)

modelled as EGARCH(1,1); eurozone money market interest rate level (three-month EURIBOR); US Treasury note yield changes; and returns on the Euro-Croatian kuna (EUR-HRK) and the US dollar-Croatian kuna (USD-HRK) exchange rates. Authors observed the first instances of coexceedances between the Croatian and other observed European stock markets occurred in the 2007, with the subprime mortgage crisis as the predecessor of the global financial crisis and they substantially increased after the second half of 2008 with the mortgage crisis forming into the full financial crisis. Additionally, the author found that the increase in the USD/HRK exchange rate increases the probability of coexceedances occurring while an increase in the HRK/USD rate has no effect. The results showed that positive DJI returns lowered the probability of extreme negative returns in the studied European stock markets. When the conditional volatility of EUROSTOXX50 increases the probability of extreme negative returns in the stock markets of Eurozone increases. Similarly increased EURIBOR rates were also associated with the increase of probability of extreme negative returns occurring in the European stock markets. Only one variable was found to be lowering the probability of extreme negative returns while increasing – the 10-year US Treasury note yield level.

Wang & Moore (2008) examined equity markets integration of the CEE Countries with aggregate eurozone stock market from 1994 to 2006. Dynamic correlation approach was used to measure the degree of integration between European stock markets. During the period of financial crisis the authors found significant dynamic correlation of the CEE stock markets and of the Eurozone stock market. They present evidence that entry to European Union has accelerated the stock market integration. This is in line with our expectations however our hypothesis count with the fact that stock markets are already integrated with the European Union markets significantly. Wang & Moore (2008) also provide evidence that financial market integration is a “self-fueling” process and depends on development of financial sectors in the CEE countries.

Saramakoon (2011) added a major contribution to the contagion literature by developing a straightforward framework for distinguishing between cross-market interdependence and contagion. Unlike most previous studies, the author framed cross-market interdependence and contagion on the basis of time-varying return shocks

rather than correlation or volatility. Saramakoon (2011) formulates the relation between return shocks of one market with another using the VAR methodology. However the author particularly considered the differences in trading hours across markets and the need to distinguish between interdependence and contagion. This approach resulted in two models – first partialy overlapping shock model and second non-overlapping shock model both of which allow for a clear separation of the transmission of shocks during times of stability vs. crisis, enabling a complete understanding of the propagation of shocks in international markets. Secondly the author provided empirical evidence on the degree of interdependence and contagion between the U.S. and emerging and frontier markets during the U.S. financial crisis. The auhot decided to put particular importance on the study of emerging and frontier markets as they have become an increasingly important asset class for investors seeking to diversify their international portfolio. As mentioned in the paper there was very little published work that examined the issue of interdependence and contagion associated return shocks generated during the U.S. financial crisis in international markets. Particularly important is the study of emerging and frontier markets, which have become an increasingly important asset class for investors in international portfolio diversification. Samarakoon (2011) proves that there exists an important bi-directional, yet asymmetric, interdependence and contagion between the U.S. and emerging markets, with important regional variations. Contagion is proved to be driven more by emerging market shocks than by U.S. shocks. Interdependence on the other hand is driven by U.S. shocks more than by emerging market shocks. In periods of tranquility the Asian emerging markets do not impact the U.S., but in periods of crisis they have a strong contagious effect on the U.S. Only evidence of contagion of U.S. crisis to an emerging market is in Latin America, there is no contagion of U.S. crisis to the emerging markets in other regions. However the author proves strong contagion from emerging markets in all regions to the U.S. Author also proves evidence of interdependence and contagion, although small in magnitude, in frontier markets with respect to U.S. shocks. Frontier markets are influenced by U.S. shocks more during crisis than during normal times, and the U.S. financial crisis had a more contagious effect on frontier markets than on emerging markets. Author claims that these findings enrich the existing literature on transmission of shocks in international capital markets. The main finding from the paper is that emerging markets have large normal

sensitivities to U.S. shocks, and large declines in stock prices in these markets reflected these dependencies rather than contagion.

2.3 Hypotheses

After the literature review we have a better understanding of how the examined markets will behave in terms of joint comovements. We have formulated the following hypotheses which we would like to confirm or reject. First that there exists contagion between the countries with the possibility to enter the EU and the EU reference market. Secondly, that the contagion in the financial markets of these countries is predictable. Finally, that the coexceedance in financial markets of these countries is affected by stock returns volatility, interest and exchange rates.

3 Data

3.1 Brief overview of the countries

According to the European Commission the accession negotiations with Montenegro to become a part of the EU were opened in June 2012. Montenegro started strives to join the EU by 2020, ahead of the other countries in the Western Balkans. In the latest European Commission (EC) Progress Report on Montenegro, the importance of maintaining macroeconomic stability was stressed, noting that the rapidly rising public debt and high fiscal deficits, together with high external imbalances and high unemployment, are of particular concern. (Wordbank, 2017a).

Macedonia experienced an extended and serious political crisis in 2014–17. EU and U.S. diplomats facilitated a dialogue between the main political parties, resulting in the formation of a new Government in June 2017. The reform agenda of the new government focuses on economic growth, job creation, fair taxation, support to small and medium enterprises, and reform of social protection for the most vulnerable. In addition, the new Government adopted a plan which includes a set of measures that will be implemented in the next three, six, and nine months to accelerate the process of EU and NATO accession, with the aim of securing a date for the start of EU accession negotiations by spring 2018 (Worldbank, 2017b).

Negotiations with Turkey started on 3 October, 2005. Accession to the EU requires Turkey to successfully complete negotiations on 33 of the 35 chapters needed to become a member state. However due to Turkey’s refusal to open its ports and airports to traffic from Cyprus accession has been staganting (Worldbank, 2014).

In March 2012 Serbia was granted EU candidate status. In line with the decision of the European Council in June 2013 to open accession negotiations with Serbia, the Council adopted in December 2013 the negotiating framework.The 21st January 2014, signals the formal start of Serbia's accession negotiations (European Commission, 2016).

Bosnia and Herzegovina was identified as a potential candidate for EU membership during the Thessaloniki European Council summit in June 2003. Since then, a number of agreements between the EU and Bosnia and Herzegovina have entered into force. No formal accession process has been put in place as of yet (European Commission, 2016).

3.2 Stock Market data

We decided to concentrate on studying the stock market contagion between the markets of European Union and the countries that are actively seeking to become a part of the European Union using the most important stock market indexes. This proves logical namely because many of the countries examined do not yet have mature stock markets; many of these markets are still in the process of growth and innovation. Secondly, as it is a usual case in immature stock markets – only a limited number of companies is being traded, mostly due to the missing infrastructure which makes it hard to create and run publicly traded companies in these regions. Therefore we expect the stock market indexes to be a quite reasonable and reliable measure for studying the stock markets in these countries as a whole.

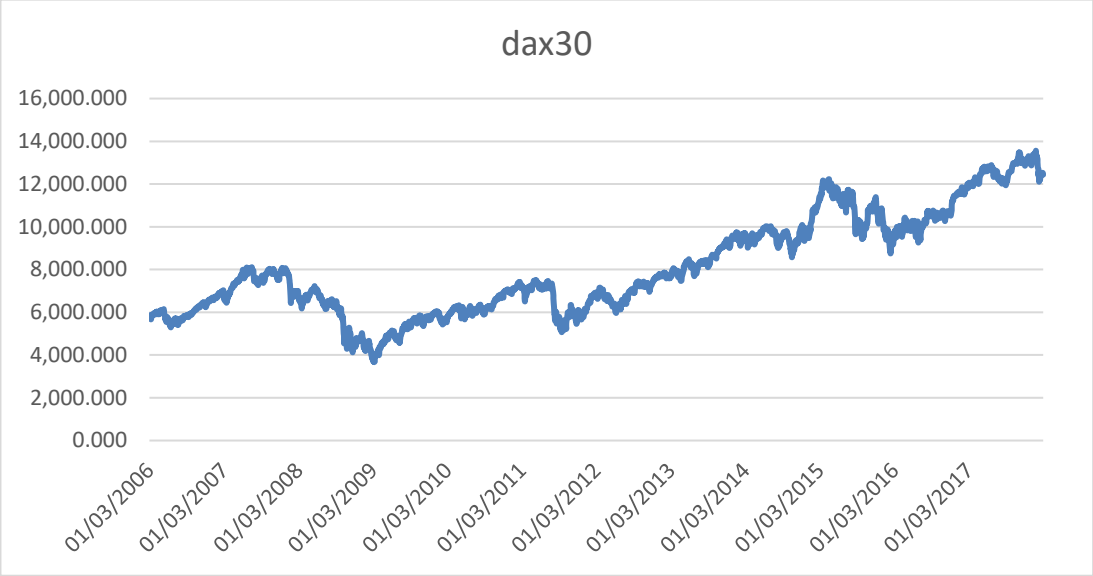
For our study, we will be using daily closing prices of the studied indexes. As reference data for the EU market we will be using the stock index of Frankfurt stock exchange – DAX30. Subsequently, we will be using stock exchange index data from the 5 countries – Montenegro, Macedonia, Serbia, Turkey and Bosnia. We decided to exclude Albania from this study due to low liquidity and capitalization of the market and also due to the fact that the Tirana stock exchange has been shut down in 2014 and is no longer functioning. The Montenegro stock exchange is represented by the MONEX 20 Index which tracks the performance of 20 biggest companies listed on the Montenegro Stock Exchange; the Istanbul Stock Exchange National 100 Index BIST100 which is a major stock market index which tracks the performance of 100 companies selected from the National Market, real estate investment trusts and venture capital investment trusts in Turkey; the Sarajevo Stock Exchange Index 10 – SASX10 - depicts the price movement of the top 10 issuers on the Bosnian stock exchange; MBI 10 - a price index weighted with market capitalization and consists of up to 10 listed ordinary shares represents the Macedonia Stock; the Belgrade BELEX15 Index which is a major stock market index which tracks the performance of 15 biggest companies

listed on the Belgrade Stock Exchange in Serbia. The examined data spans from 3rd March 2006 to 30th March 2018. We omitted days when at least one of the examined markets in each pair of markets was not trading. Daily closing prices of examined indices were sourced from Thomson Reuters Eikon.

3.3 Germany

We will be using Frankfurt stock market index as the reference market for European Union meaning that all the other markets will be compared to the German stock market. From Figure 1 we can see that DAX has recovered from the financial crisis completely and the current prices exceed its price in the pre-crisis period. The maximum price of the index was realized on 23rd January 2018 with 13,559.600 points, the minimum price was realized on 6th March 2009 with 3,666.410 points. Up until the beginning of 2008 the index price was rising steadily surpassing 8,000 points at the end of 2007. During the period of financial crisis the index price dropped below 4,000 points in the first quarter of 2009. After the reached minimum we see a climbing trend in the price up until the middle of 2011 where the index reached more than 7,000 points. Following was a drop in the middle of 2011 where the price fell under 6,000 points. From 2012 onwards we again see a rising trend up until 2015 where the price peaked above 12,000 points. In 2015 the index price again lowered to less than 9,000 points, however began to rise in the end of 2015 reaching the peak if over 13,000 points in the beginning of 2018. The market has recovered after the financial crisis, we can clearly see from Figure 1 that the price of the index in 2018 has almost doubled compared to its pre-crisis value.

Figure 1 Frankfurt Stock Market Index in the period from March 1st, 2006 to February 28th, 2018

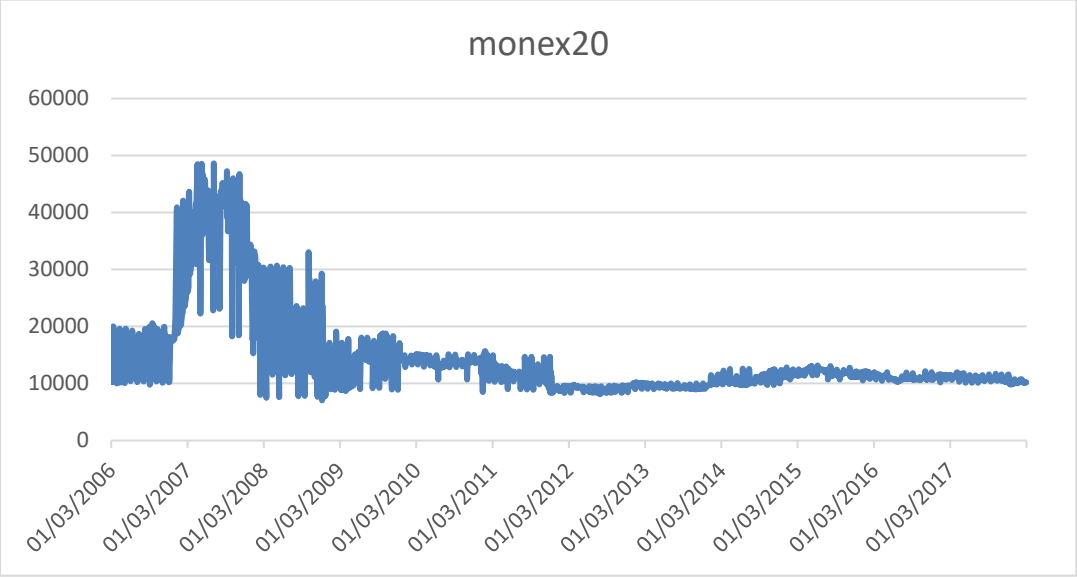


Source: author's computations.

3.4 Montenegro

The number of observations is $T_i = 2841$. From Figure 2 we can see that the index prices were extremely volatile mainly in the period before and during the financial crisis. During 2006 we can see the price jumping almost over 10,000 points within weeks. The price is even more volatile from March 2007 throughout the end of 2008. The maximum value for the index was 48,617.88 points on 5th July 2007. The minimum was reached on 4th December 2008 with 7,052.32 points. Shortly before the financial crisis the index was peaking with values oscillating around 25,000 to 47,000 points. During the financial crisis of 2008 the index started dropping sharply returning to its pre-crisis values up until the end of 2009. Price movements have reduced significantly after the crisis, we can see from Figure 2 that during 2010 and 2011 the price movements were centered between the values of 10,000 to 15,000 points. From 2012 onwards the price has stabilized at values of around 10,000 points. We do not see any indication of the index climbing back to its pre-crisis values nor do we see any indication of the price rising in the future, the index seem to be stagnating.

Figure 2 Montenegro Stock Market Index in the period from March 1st, 2006 to February 28th, 2018

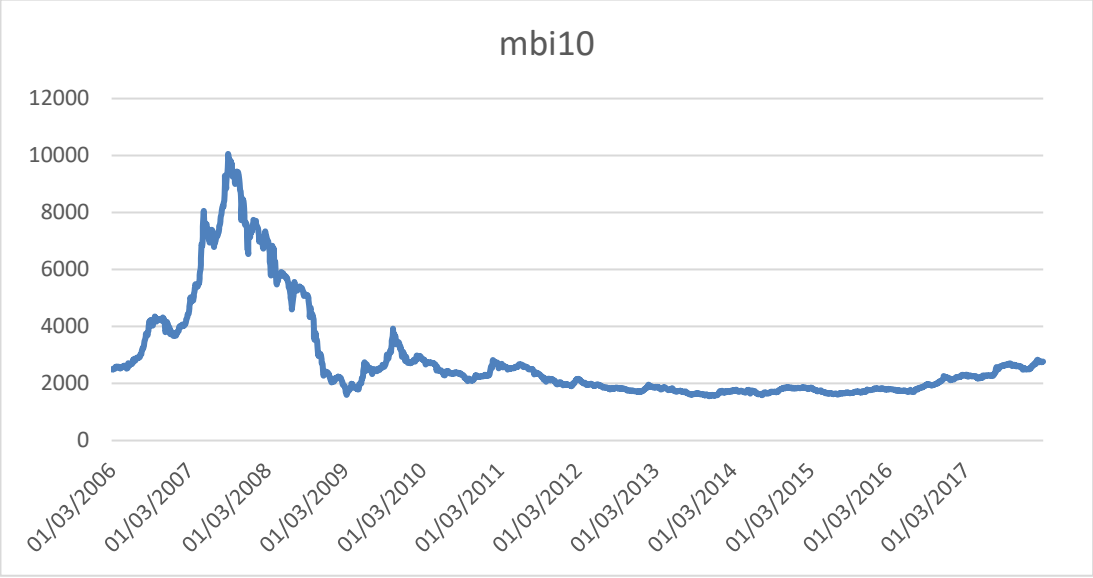


Source: author's computations.

3.5 Macedonia

The number of observations is *Ti* = 2793. The maximum value of the index price was reached on 31st August 2007 with 10,057.7703 points, the minimum on 8th November 2013 with 1,556.96 points. From Figure 3 we can see that Macedonia's stock market was experiencing a very steep rise of the market index price from the end of 2006 until the end of 2007. We see a sharp decline in the index starting from the middle of 2007 until the beginning of 2009. In 2009 the market seems to have stabilized with only a small peak in price of the index at the end of 2009. From the figure we can visibly conclude that since 2010 the price has been circulating around the average value of 2,000 points which corresponds to its value in the beginning of 2006. It is clear that the market has not recovered from the financial crisis. We see a small increase in the price of the index in the end of 2017 and beginning of 2018.

Figure 3 Macedonian Stock Market Index in the period from March 1st, 2006 to February 28th, 2018



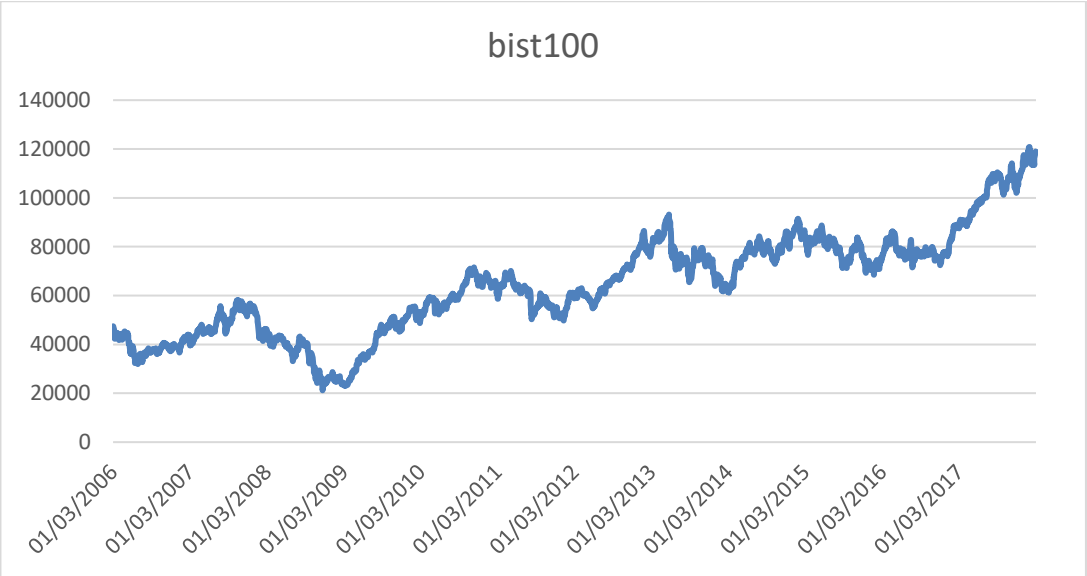
Source: author's computations.

3.6 Turkey

The number of observations is *Ti* = 2840. From Figure 4 we can see that Istanbul Stock Market is the only examined non-EU market that has recovered after the crisis and currently has a higher index price than in the pre-crisis period. The maximum value was realized on 29th January 2018 with 120,845.29 points, the minimum on 20th November 2008 with 21,228.27 points. In the beginning of 2006 the value of the index was above 40,000 points. There was a slight decline in the price in the midst of 2006 followed by a period of rise with a peak in price at the end of 2007 where the index rose above 57,000 points. With the onset of financial crisis the price again followed a declining path with the price hitting its low of slightly above 21,000 points in the end of 2008. From 2009 onwards the price again climbs up to over 60,000 points in 2010 and 2011, it is evident that the country started to recover from financial crisis early on. Another short period of decline of the price is visible in 2011 where the index again steps under 60,000 points. Another peak in price is visible in second quarter or 2013 with price hitting above 90,000 points. From the middle of 2015 until 2017 the

price oscillates around the value of 80,000 points. There is a sharp rise in 2018 where the price hits over 120,000 points in its peak, which corresponds to Turkey currently being one of the fastest growing economies in the world.

Figure 4 Istanbul Stock Market Index in the period from March 1st, 2006 to February 28th, 2018



Source: author's computations.

3.7 Serbia

The number of observations is *Ti* = 2867. From Figure 5 we can see a very similar pattern to the other stock market indices. The index has reached its peak on 3rd May 2007 with 3,304.64 points. The lowest price for the index was recorded on 11th March 2009 with 354.39 points. The index price started to climb up steadily from the middle of 2006 from an average value of 1,100 points up to more than 3,300 points in mid-2007. After this peak we see a sharp decline further enhanced by the financial crisis. We observe values of less than 500 index points in the middle of 2009. There was a slight increase in the index price during the financial crisis in 2009 and 2010 which persisted into the middle of 2011 where the price reached an average value of 700 points, only to further devaluate from 2011 throughout 2013 back to values of about 500 points. Similarly to the other indices, it is visible that the market has not

recovered from the financial crisis with only a small increase in the price of the index from 2016 onwards. The index has not managed to reach its pre-crisis price.

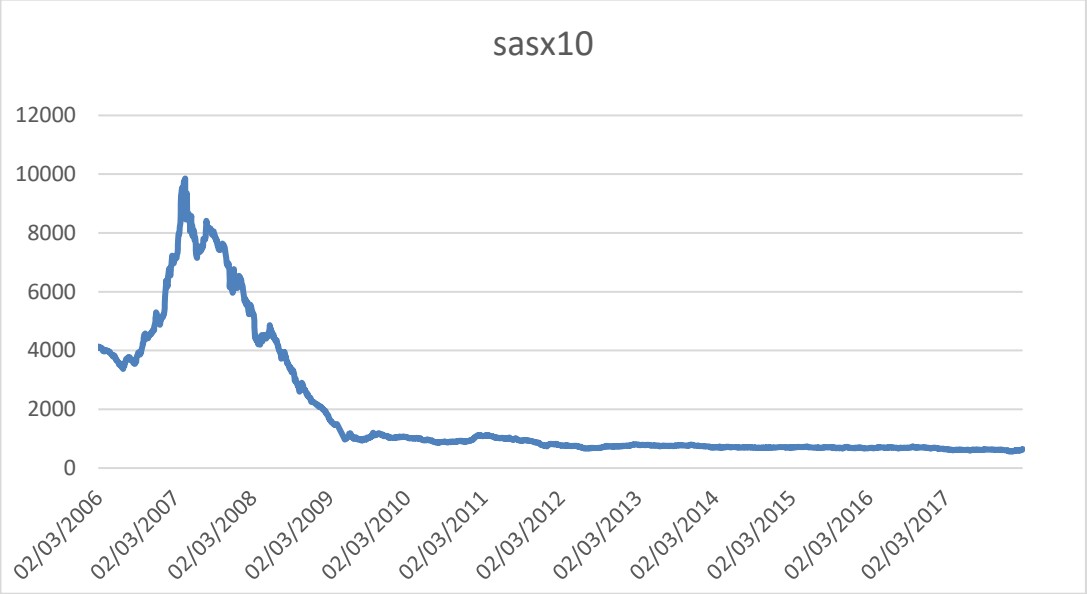
Figure 5 Belgrade Stock Market Index in the period from March 1st, 2006 to February 28th, 2018

Source: author's computations.

3.8 Bosnia

The number of observations is $Ti = 2829$. From Figure 6 we can see that during 2006 we the price was steadily decreasing from around 4,000 points to 3,700 points. We see a steep jump in price throughout 2006 to the beginning of 2007 to almost 10,000 points. The maximum value for the index was 9853.78 points on 17th April 2007. The minimum was reached on 28th and 29th December 2017 with 562.49 points. In 2007 before the financial crisis the index was peaking with values between 8,000 to almost 10,000 points. In late 2007 the index started dropping sharply, going significantly under its pre-crisis values up until the middle of 2009. Price movements have reduced significantly after the crisis, we can see from Figure 6 that from middle of 2007 there are virtually no price movements with values centered between 500 to 750 points. Similarly to Montenegro, we do not see any indication of the index climbing back to its pre-crisis values nor do we see any indication of the price rising in the future.

Figure 6 Sarajevo Stock Market Index in the period from March 2nd, 2006 to February 28th, 2018



Source: author's computations.

4 Methodology

For our study we will use the coexceedance methodology of Bae et al. (2003) to investigate integration between the financial markets of the candidate countries trying to join the European Union and financial markets in the EU. In order to examine the occurrences and the extent of coexceedances in these markets we will use quantile regression framework. Frist step will be to obtain the volatility measures, using autoregressive model to decompose variance. After we will use the quantile regression framework to study return coexceedances to uncover the excess return co-movement.

4.1 Coexceedance definition

Bae et al. (2003) define contagion as a joint occurrence of extreme (negative) returns within a group of markets. Authors subsequently defined exceedance as an occurrence of an extreme return above or below a certain threshold - 5th quantile for extreme negative return and 95th quantile for extreme positive return from the whole distribution of returns. Coexceedance is defined as a joint occurrence of extreme positive (negative) returns in two or more markets at the same time. Baur and Schulze (2005) later modified the coexceedance model of Bae et al. (2003) by including a magnitude measurement. For two markets X and Y, the coexceedance of two standardized market returns Ex and Ey at time t is defined similarly to Baur and Schulze (2005) by the following:

$$C(E_{xt}, E_{yt}) = \begin{cases} min(E_{xt}, E_{yt}) \\ max(E_{xt}, E_{yt}) \\ 0 \end{cases} \quad if \quad \begin{array}{c} E_{xt} > 0 \wedge E_{yt} > 0 \\ E_{xt} < 0 \wedge E_{yt} < 0 \\ E_{xt} * E_{yt} < 0 \end{array} \tag{1}$$

The equation can be interpreted as the size of the movement that is shared by markets *X* and *Y*. We measured coexceedances using

standardized stock market return with zero mean and variance one. Coexceedances were always measured in pairs for examined country and the EU reference market.

4.2 Quantile regression

For the analysis of coexceedances between stock markets we decided to use the quantile regression model of Koenker and Bassett (1978). The use of quantile regression is in line with the analyses done by Horvath et al. (2015) or by Baur (2013), as this model proves to be useful when analyzing extreme stock market returns. A simple linear quantile regression equation is given as follows:

$$C_{ij} = X^T\beta(q) + \varepsilon(q) \tag{2}$$

where C_{ij} denotes the *(T x 1)* vector of coexceedances, X is a *(T x k)* matrix of *k-1* exogenous variables and constant, $\beta(q)$ is the *(k x 1)* vector of unknown parameters and $\varepsilon(q)$ is the *(T x 1)* vector of disturbances, where q is the specification of the percentile. The error term is assumed to be zero conditional on X, i.e. $Q_{\varepsilon(q)}(q|X) = 0$. From this assumption and the equation (2) we arrive at the *(q)th* conditional quantile of C_{ij} to be:

$$Q_{C_{ij}}(q|X) = X^T\beta(q) \tag{3}$$

We denote $x^T{}_t$ as a vector of independent variables at time $t = 1, 2, \ldots, T$. The quantiles are formulated as the solution to equation (4) minimization problem of weighted absolute deviations between coexceedances and a linear combination of independent variables. Confidence intervals are constructed using standard errors of the quantile regression coefficients estimated via bootstrapping. The minimization problem can be formulated as a linear program solved by an algorithm used in Koenker and D'Orey (1987, 1994).

4.3 Model of coexceedances between stock markets

We consider following specification of the model to explain coexceedances between the examined stock markets and reference market of the EU:

$$Q_{Cij}(\tau|X) = \beta_0(\tau) + \beta_1(\tau)Y_t^{DE} + \alpha_1(\tau)Y_t^{EU} + \gamma_1(\tau)R_t^{DAX} + \gamma_2(\tau)\sigma_t^{DAX} + \mu_1(\tau)R_t^{BRN} + \mu_2(\tau)\sigma_t^{BRN} + \omega_1(\tau)EC_t^{USDEUR} + \omega_1(\tau)D_1^{FC} + \omega_2(\tau)D_2^{AC} + \varepsilon_1(\tau)\sigma_t^{i} + \vartheta_1(\tau)C_{t-1} \quad (4)$$

where Y_t^{DE} is the market yield of 10 year government bonds of Germany, Y_t^{EU} is the market price of 10 year Europen corporate government bonds, R_t^{DAX} is the continuous daily return of the Frankfurt Stock Exchange Index, σ_t^{DAX} is the estimated conditional variance (volatility) of the return of the Frankfurt Stock Exchange Index, R_t^{BRN} is the continuous daily return from the Europe Brent Spot Price, σ_t^{BRN} is the estimated conditional variance (volatility) of the return of the Europe Brent Spot Price, EC_t^{USDEUR} is the continuous daily return of the USD/EUR exchange rate, D_1^{FC} is the first dummy variable which represents the financial crisis period from September 2nd, 2008 to April 30th, 2010, D_2^{SDC} is the second dummy variable which represents the period after crisis from May 3rd, 2010 till the end of the examined period, σ_t^i is the estimated conditional variance (volatility) of the examined market i, and C_{t-1} is the lagged coexceedance. Based on AIC and BIC all conditional variances (volatilities) for stock markets were constructed as GARCH (1, 1). These explanatory variables were chosen in light of previous literature on financial contagion. Horvath et al. (2015) used high quality bonds in their analysis, this corresponds to our inclusion of German 10 year government bond yields and Europe 10 year corporate government bond prices. We use returns of Europe Brent spot price and the expected volatility of Europe Brent spot price as we suspect that both change in spot price and the volatility of oil prices will prove to have an impact in our analysis, as they usually do have impact on the whole economy. Similarly to Dajcman (2014) we decided to use exchange rate as one of our explanatory variables, since we aim to prove contagion from EU to the examined market we chose to include the daily change of USD/EUR rate as the base reference currency for EU. We used a dummy variable for the financial crisis to capture the effects of a turbulent period. This is in line with studies concluded for example by Horvath et al. (2015) or Baur and

Schulze (2005). Second dummy variable used captures the period after financial crisis, we use it mainly due to our expectation that contagion would be more prevalent after the very unstable period of the financial crisis. We also include expected volatility (conditional variance) of the examined market constructed based on GARCH (1, 1).

Subsequently we will be using a model stripped of the dummy variables to explain coexceedances solely in the period of financial crisis:

$$Q_{Cij}(\tau|X) = \beta_0(\tau) + \beta_1(\tau)Y_t^{DE} + \alpha_1(\tau)Y_t^{EU} + \gamma_1(\tau)R_t^{DAX} + \gamma_2(\tau)\sigma_t^{DAX} + \mu_1(\tau)R_t^{BRN} + \mu_2(\tau)\sigma_t^{BRN} + \omega_1(\tau)EC_t^{USDEUR} + \varepsilon_1(\tau)\sigma_t^{i} + \vartheta_1(\tau)C_{t-1} \quad (5)$$

We suspect that coexceedance effects will be more prevalent in the highly turbulent period of the financial crisis. For both models we use bootstrap 500 to obtain robust results of quantile regression. All our computations have been performed in STATA.

5 Results

5.1 Descriptive statistics

In the following Table 1 we can see the descriptive statistics of the stock market indices returns, Europe Brent spot price returns, German 10 year bond yields and Euro corporate bond prices from March 03, 2006 to February 28, 2018.

Table 1 Descriptive statistics of German & reference countries stock market indices returns, return of Brent, German 10 year government bond yields and 10 year Eurobond prices from March 2006 to February 2018.

	Mean	Min	Max	Date min	Date max	St. Dev	Skewness	Kurtosis
Germany	0.026214%	-8.40%	13.46%	12/11/2008	14/10/2008	0.01	0.03644	7.42796
Montenegro	-0.000447%	-135.79%	128.87%	04/12/2008	13/02/2008	0.14	0.61888	29.056
Serbia	-0.013775%	-10.86%	17.32%	07/10/2008	29/12/2008	0.01	1.0224	25.441
Turkey	0.032340%	-11.06%	12.13%	03/06/2013	19/09/2008	0.02	-0.2994	4.0449
Macedonia	0.003759%	-10.28%	10.69%	16/10/2009	25/03/2008	0.01	-0.1684	11.9481
Bosnia	-0.065819%	-41.37%	7.57%	12/05/2009	23/04/2007	0.01	-11.141	352.549
Brent	0.002723%	-16.83%	26.35%	05/12/2008	05/01/2009	0.02	0.38135	10.306
German bonds	2.15	-0.187	4.686	08/07/2016	19/06/2008	1.44	0.07753	-1.384
Eurobonds	116.99	96.78	139.1	23/07/2008	07/09/2016	12.68	0.13981	-1.4016

Source: Author's computations.

Mean is positive for German, Turkish and Macedonian returns, three of the five non-EU stock markets in question have a negative mean. All index return means are very close to zero. We can see that most of the minimum and maximum values have been realized during the period of the financial crisis. Turkish, Bosnian and Macedonian stock markets exhibit negative skewness, the rest of the markets are skewed positively. All stock market indices and Europe Brent spot price distributions are leptokurtic. Both analyzed bonds' distributions are platykurtic.

5.2 Correlations

In the following Table 2 we can see the unconditional correlations between the markets, bonds and Brent price. The correlation of all non-EU markets with the German market are positive, which indicates that the markets will move in the same direction. However the correlation coefficient is very low for Germany – Montenegro and Germany – Bosnia therefore there is only a small linear relationship between these markets. We see evidence of strong positive correlation only between Germany and Turkey. We see evidence of negative correlation between markets of Serbia and Montenegro and Turkey and Montenegro. We do not see any strong positive or negative correlations between the non-EU markets, which was not expected as we were predicting there would be a regional economic relationship present. All markets except Montenegro are negatively correlated with German bond yields.

Table 2 Unconditional correlation structure between German & reference countries stock market indices returns, return of Brent, German 10 year government bond yields and 10 year Eurobond prices from March 2006 to February 2018.

	Germany	Serbia	Monte-negro	Turkey	Mace-donia	Bosnia	Brent	Euro bonds	German bonds
Germany	1.0000								
Serbia	0.1716	1.0000							
Montenegro	0.0035	-0.0063	1.0000						
Turkey	0.5168	0.1068	-0.0245	1.0000					
Macedonia	0.1293	0.2390	0.0394	0.1253	1.0000				
Bosnia	0.0176	0.1403	0.0480	0.0002	0.1009	1.0000			
Brent	0.3308	0.0906	-0.0271	0.2141	0.0783	-0.0079	1.0000		
Euro	0.0147	0.0522	-0.0090	0.0043	0.0372	0.0682	0.0097	1.0000	

bonds									
German bonds	-0.0086	-0.0258	0.0100	-0.0087	-0.0069	-0.0414	0.0014	-0.9517	1.0000

Source: Author's computations.

We computed unconditional correlations between markets specifically for the financial crisis period in Table 3. As expected most of the correlations have increased which points to the probability of contagion during this period. We aim to confirm that conditional quantile estimates can be used to detect crisis period and direction of contagion.

Table 3 Unconditional correlation structure between German & reference countries stock market indices returns, return of Brent, German 10 year government bond yields and 10 year Eurobond prices in the period of 2008 – 2010 financial crisis

	Germany	**Serbia**	**Monte-negro**	**Turkey**	**Macedonia**	**Bosnia**	**Brent**	**Euro bonds**	**German bonds**
Germany	1.000								
Serbia	0.2969	1.000							
Montenegro	0.0317	0.0741	1.000						
Turkey	0.648	0.2244	-0.0054	1.000					
Macedonia	0.2051	0.3594	0.023	0.2884	1.000				
Bosnia	0.0466	0.1381	0.0723	-0.0107	0.1163	1.000			
Brent	0.4783	0.1569	-0.1125	0.391	0.2214	0.0207	1.000		
Eurobonds	0.0456	0.1448	-0.0125	0.045	0.1198	0.104	0.1212	1.000	
German bonds	-0.0126	-0.1093	0.0017	-0.0982	-0.095	-0.0067	-0.0573	-0.4317	1.000

Source: Author's computations.

5.3 Coexceedances

In Table 4 we can see the counted positive and negative coexceedances between the reference EU market Germany and the examined markets. Interestingly we can see that only the stock market of Turkey exhibits positive coexceedances with the stock market of Germany. Correlation between Turkish and German stock market was the

also highest from analyzed countries, so the highest occurrence of coexceedances has been expected. The other markets' positive coexceedances correspond to less than 0.2% out of the whole sample which is statistically very insignificant. The results in Table 4 are no in line with the hypothesis that there exist positive coexceedances between the markets and the EU reference market as we do not find evidence of positive coexceedances for Montenegro, Serbia, Bosnia and Macedonia. As we can see joint negative returns occurred throughout all the markets.

Table 4 Positive and negative coexceedances between reference market of Germany and the examined markets

	Observations	Positive	Negative
DAX-MONEX	2841	5	986
DAX-BELEX	2867	6	1099
DAX-BIST	2840	1100	1386
DAX-MBI	2793	8	1042
DAX-SASX	2829	3	991

Source: Author's computations.

In the following Table 5 are descriptive statistics of the coexceedances between Germany and examined markets of Montenegro, Serbia, Macedonia and Bosnia. All coexceedances are on average close to zero and negative with only the exception of Turkey. Also all coexceedances are negatively skewed except for Germany-Turkey. The lowest negative joint returns between analyzed countries are all detected during the period of financial crisis except for Bosnia. The highest positive joint returns also all occurred during the financial crisis only with the exception of Turkey where the highest coexceedance happened recently in January 2018. The median value of all coexceedances is 0 as expected.

Table 5 Descriptive Statistics of coexceedances between Germany and examined markets

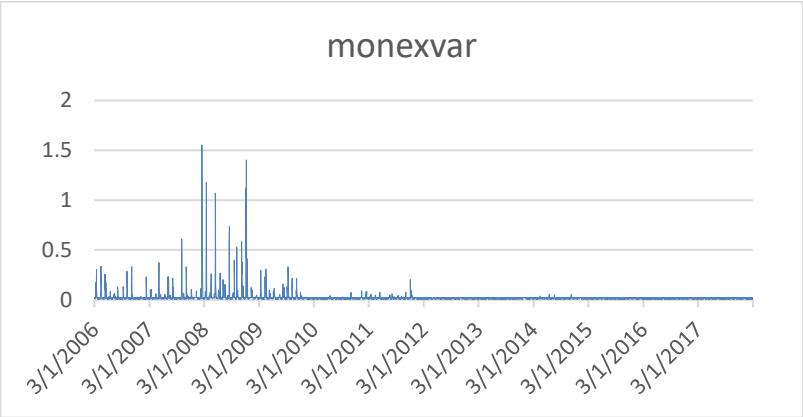
	Median	Mean	Min	Max	Date Min	Date Max	StDev	Skewness	Kurtosis
DAX-MONEX	0	-0.117472	-0.931181	0.02205	04/12/2008	16/07/2007	0.20969	-1.6894417	1.5416

DAX-BELEX	0	-0.157987	-0.880243	0.01933	11/03/2009	16/07/2007	0.23223	-1.1810917	0.07363
DAX-BIST	0	0.0275288	-1.873586	2.33983	06/03/2009	23/01/2018	0.82785	0.4332146	0.17345
DAX-MBI	0	-0.109753	-0.730892	0.02378	10/03/2009	16/07/2007	0.17495	-1.4322481	0.77473
DAX-SASX	0	-0.136496	-0.575978	0.00678	11/07/2012	16/07/2007	0.19933	-0.9146705	-0.9545

Source: Author's computations.

In the following Figure 7 is the estimated conditional variance (volatilities) of the Montenegro stock exchange index. It was very obvious in the data that the Montenegro stock exchange index would be highly volatile, the conditional variance estimate below is very much in line with this assumption. We can see that mainly in the period of the financial crisis the volatility reaches substantial values, not typical values for conditional variance. However after the period of crisis we do not see any peaking volatility.

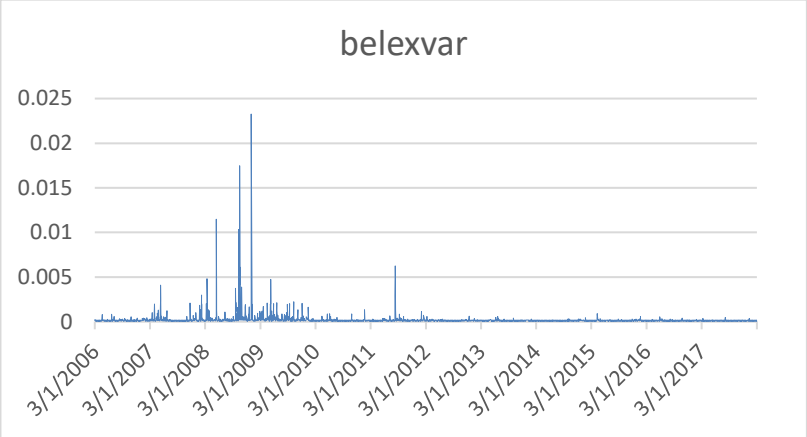
Figure 7 Estimated conditional variance of Montenegro stock market from March 1st 2006 to February 28th 2018



Source: Author's computations.

In Figure 8 we see that the conditional variance of the Serbian stock market is not reaching very high values. There was a peak in volatility during the crisis which is in line with our expectations however after the period of crisis we do not see any peaks.

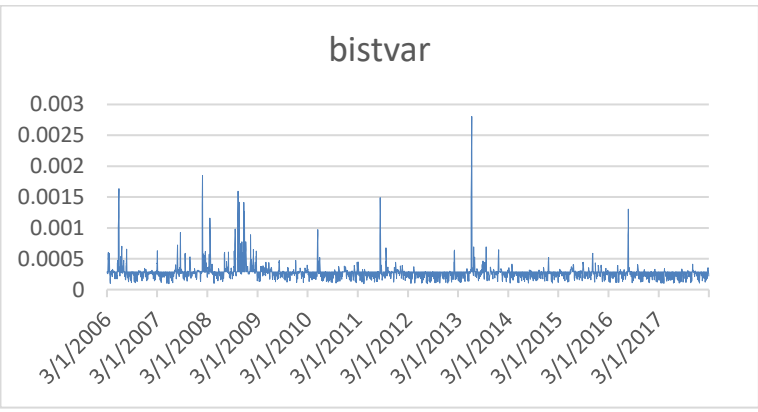
Figure 8 Estimated conditional variance of Serbian stock market from March 1st 2006 to February 28th 2018



Source: Author's computations.

In Figure 9 we see the conditional variance for the stock exchange index of Turkey. The volatility overall is relatively low with only some peaks during the financial crisis in 2008 and 2009 and in the beginning of 2013.

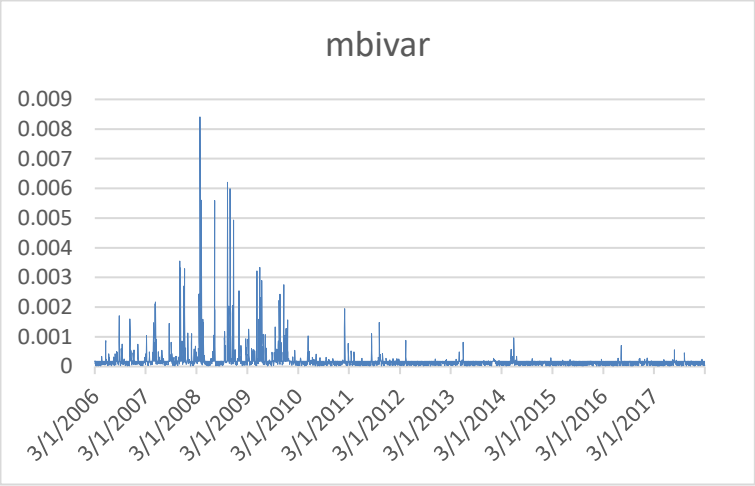
Figure 9 Estimated conditional variance of Turkish stock market from March 1st 2006 to February 28th 2018



Source: Author's computations.

In Figure 10 we can see that the Macedonian stock index is exhibiting periods of very high volatility during the financial crisis of 2008 and 2009. Before the crisis the conditional variance was relatively low and following the crises we see only very little volatility in the data.

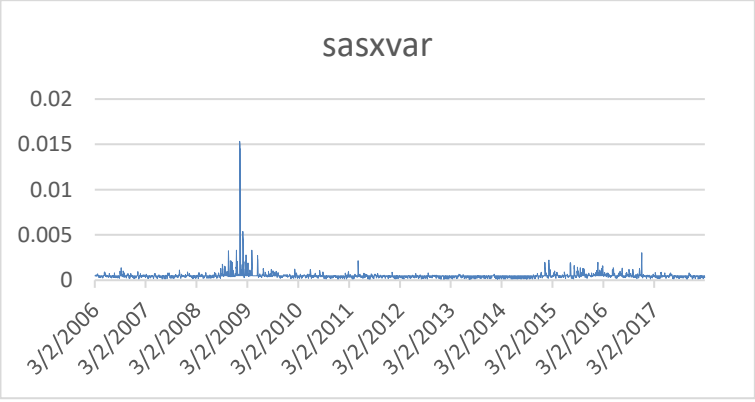
Figure 10 Estimated conditional variance of Macedonian stock market from March 1st 2006 to February 28th 2018



Source: Author's computations.

In Figure 11 we can see that the conditional variance of the Bosnian stock market index is relatively low. The only peak in the volatility we see in the end of 2008 which would correspond to the period of financial crisis.

Figure 11 Estimated conditional variance of Bosnian stock market from March 2nd 2006 to February 28th 2018



Source: Author's computations.

5.4 Quantile regression results for the whole examined period

5.4.1 Germany – Montenegro

The results of Quantile regression of Model 1 from equation (4) of German and Montenegro stock market coexceedances are in Appendix A in Table 1. Surprisingly yields of 10 year government bonds of Germany have almost no influence on occurrence of coexceedances at all reported quantiles, with only the exception of the very first qantile where we see a significant small positive influence on the negative co-movements. We see that the price of 10 Year Eurobond is significant in first three quantiles however with very small positive influence and is not significant in the higher reported quantiles. Return of DAX also surprisingly has almost no influence on the reported quantiles except quantiles 5 and 10 where we see a very small significant positive influence. Volatility of DAX does not have any significant influence on any of the reported quantiles. Return of crude oil (Brent) and its volatility significant does not have any influence on occurrence of coexceedances and is not significant in any of the reported quantiles. The returns of USD/EUR exchange rate is only significant in the 10^{th} quantile, and has a positive influence on the negative coexceedances. The same applies to the after crisis dummy variables which is also only significant in the 10^{th} quantile, however with a negative influence. Dummy variable for financial crisis is surprisingly not significant in any of the examined quantiles. Volatility of MONEX is not significant in any of the examined quantiles. Lagged value of coexceedance between DAX and MONEX is significant on all the analyzed quantiles and has a positive influence on the occurence of the negative comovements. We cannot conclude that the specified model explains the joint negative occurences between the markets of Germany and Montenegro as most of the used variables do not produce significant coefficients. As a result of variables not explaining the model properly we were only able to compute quantile regression results for quantiles 1, 5, 10, 25 and 50.

5.4.2 Germany – Serbia

The results of Quantile regression of Model 1 from equation (4) of German and Serbian stock market coexceedances are in Appendix A in Table 2. Yields of 10 year government bonds of Germany are only significant in quantile 1 with small positive influence on the negative coexceedances. German bond yields are not significant in any other examined quantile. Similarly, the 10 year Eurobond prices are only significant in quantile 1 with small positive influence and are not significant in any other examined quantile. The returns of DAX have a significant positive influence in quantiles 1 and 5 and no significant influence in quantiles 10 and 25. Volatility of DAX does not have any significant influence on any of the reported quantiles. Return of crude oil (Brent) and its volatility significant does not have any significance in the model on occurrence of coexceedances in any of the reported quantiles. The returns of USD/EUR exchange rate is only significant in the 5^{th} quantile, and has a positive influence on the negative coexceedances. The after crisis dummy variables which is also not significant in any of the quantiles. Dummy variable for financial crisis significant in the 5^{th}, 10^{th} and 25^{th} quantiles and is negatively influencing the negative market comovements. Volatility of BELEX is only significant in the 1^{st} quantile and has a strong negative influence on the negative coexceedances. Lagged value of coexceedance between DAX and BELEX is significant in all the analyzed quantiles and has a positive influence on the occurence of the negative comovements. Like in the previous case of Montenegro, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Serbia as most of the used variables do not produce significant coefficients. As a result of variables not explaining the model properly we were only able to compute quantile regression results for quantiles 1, 5, 10 and 25.

5.4.3 Germany – Turkey

The results of Quantile regression of Model 1 from equation (4) of German and Turkish stock market coexceedances are in Appendix A in Table 3. Surprisingly, the yield of 10 year German government bonds and the price of 10 year Eurobonds is not significant in any of the estimated quantiles. The return of DAX on the other side is significant in all of the estimated quantiles with a positive influence on both negative

and positive joint comovements. On the other hand volatility of DAX does not have any significant influence on any of the reported quantiles. Return of crude oil (Brent) and its volatility significant does not have any significance in the model on occurrence of coexceedances in any of the reported quantiles. The returns of USD/EUR exchange rate is not significant in any of the quantiles. The after crisis dummy variable is significant in the 1st, 10th, 90th and 95th quantiles. Its influence is negative on the negative market coexceedances and positive on the positive market coexceedances. Dummy variable for financial crisis significant in the 1st, 5th, 10th, 75th, 90th and 95th quantiles. Similarly to the after crisis dummy, it is negatively influencing the negative market comovements and positively influencing the positive market comovements. Volatility of BIST is not significant in any of the quantiles. Lagged value of coexceedance between DAX and BIST is significant in all the reported quantiles and has a positive influence on the occurrence of both positive and negative comovements. We cannot conclude that the specified model explains the joint negative and positive occurrences between the markets of Germany and Turkey as most of the used variables do not produce significant coefficients.

5.4.4 Germany – Macedonia

The results of Quantile regression of Model 1 from equation (4) of German and Macedonian stock market coexceedances are in Appendix A in Table 4. The yield of 10 year German government bonds and is not significant in any of the estimated quantiles. The price of 10 year Eurobonds is only significant in the very first quantile and has a small positive relationship on the negative coexceedances. Similarly, returns of DAX are only significant in the 1st quantile with small positive relationship on the negative comovements. The volatility of DAX, the return of Europe Brent spot price, the volatility of Europe Brent spot price and the returns of USD/EUR exchange rate do not produce any significant coefficients in any of the estimated quantiles. The crisis dummy variable is significant in the first and fifth quantiles and has a negative influence on the coexceedances. Dummy variable for the period after financial crisis is as well significant in the first and fifth quantiles and is negatively influencing the negative market comovements. The volatility of MBI does not show any significance in any of the estimated quantiles. Lagged value of coexceedance between DAX and

MBI is significant in all the reported quantiles and has a positive influence on the negative comovements between markets. Like with the previous regression estimates, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Macedonia as most of the used variables do not produce significant coefficients. As a result of variables not explaining the model properly we were only able to compute quantile regression results for quantiles 1, 5, 10, 25 and 50.

5.4.5 Germany – Bosnia

The results of Quantile regression of Model 1 from equation (4) of German and Bosnian stock market coexceedances are in Appendix A in Table 5. The German 10 year bond yields do not produce any significant coefficients in any of the examined quantiles. The 10 year Eurobond prices are significant in the first and fifth quantile and have a very small positive effect on the negative coexceedances. Both returns of DAX and volatility of DAX have no significant effect on the market comovements. The same applies for Brent returns and Brent volatility as they also produce insignificant coefficients. Additionally also USD/EUR exchange rate returns are insignificant in all analyzed quantiles. Unlike in the previous estimations the dummy variable for financial crisis is insignificant in all quantiles. The after crisis dummy variable is significant in the first and fifth quantiles but has only small negative effect on the negative coexceedances. Volatility of SASX does not have any effect on the co-exceedances as it is insignificant in all quantiles. Lagged value of coexceedance between DAX and SASX has a negative effect on occurrence of negative co-exceedances. Again like with the previous regression estimates, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Bosnia as most of the used variables do not produce significant coefficients. As a result of variables not explaining the model properly we were only able to compute quantile regression results for quantiles 1, 5, 10 and 25.

5.5 Quantile regression results for the period of financial crisis

We decided to specifically construct quantile regression models with the restriction of the examined period to only the financial crisis from September 2nd, 2008 to April 30th, 2010. The main motivation behind including these restricted regressions is the substantial prevalence of negative coexceedances for four of the five examined markets. Also four of the five examined markets do not show any significant development of their stock markets after the period of crisis therefore with these regressions we aim to prove a more significant relation of the included variables on the joint comovements. We expect the volatilities of the reference market and of the examined markets to have more significant coefficients in the quantile regressions.

5.5.1 Germany – Montenegro during crisis

The results of Quantile regression of Model 2 from equation (5) of German and Montenegro stock market coexceedances are in Appendix A in Table 6. In line with the findings from the model for the complete period, yields of 10 year government bonds of Germany have no influence on occurrence of coexceedances at all reported quantiles, as all estimated coefficients for this variable are insignificant. We see that the price of 10 Year Eurobond is significant in fifth and tenth quantiles however with only a very small positive influence and is not significant in the higher reported quantiles. The same as German bonds, return of DAX has no significance in explaining the comovements between markets. Volatility of DAX does not have any significant influence on any of the reported quantiles. Return of crude oil (Brent) and its volatility significant does not have any influence on occurrence of coexceedances and is not significant in any of the reported quantiles. The returns of USD/EUR exchange rate is as well not significant in any of the examined quantiles. Volatility of MONEX is not significant in any of the examined quantiles. Lagged value of coexceedance between DAX and MONEX is significant in the 5^{th}, 25^{th}, 50^{th} and 75^{th} analyzed quantiles and has a positive influence on the occurence of the negative comovements. We cannot conclude that the specified model explains the joint negative occurences between the markets of Germany and Montenegro even during the financial crisis as most of the

used variables do not produce significant coefficients. As a result of variables not explaining the model properly we were only able to compute quantile regression results for quantiles 1, 5, 10, 25 and 50 and 75.

5.5.2 Germany – Serbia during crisis

The results of Quantile regression of Model 2 from equation (5) of German and Serbian stock market coexceedances during the period of crisis are in Appendix A in Table 7. Yields of 10 year government bonds of Germany are only significant in quantiles 25, 50 and 75 however with only a very small positive influence on the negative coexceedances. German bond yields are not significant in any other examined quantile. The 10 year Eurobond prices are significant from quantile 1 throughout quantile 75, but the positive influence of the variable is even lower than for the German bond yields. The returns of DAX have a significant positive influence only in quantile 99 and no significant influence in any of the other examined quantiles. Volatility of DAX does not have any significant influence on any of the reported quantiles. Return of crude oil (Brent) and its volatility significant does not have any significance in the model on occurrence of coexceedances in any of the reported quantiles. The returns of USD/EUR exchange rate unlike in the non-restricted regression is not significant in any of the estimated quantiles. Volatility of BELEX is not significant in any of the quantiles and therefore has no influence on the negative coexceedances. Lagged value of coexceedance between DAX and BELEX is significant in all the analyzed quantiles and has a positive influence on the occurence of the negative comovements. Like in the previous case of Montenegro, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Serbia during the period of financial crisis as most of the used variables do not produce significant coefficients.

5.5.3 Germany – Turkey during crisis

The results of Quantile regression of Model 2 from equation (5) of German and Turkish stock market coexceedances during the period of crisis are in Appendix A in Table 8. The yield of 10 year German government bonds is significant in the 95^{th} and

99th quantile and has a small positive effect on the market comovements in these quantiles. The price of 10 year Eurobonds is significant in the 5th quantile and has a small negative influence on the joint negative occurences between the markets of Germany and Turkey. The price of 10 year Eurobonds is also significant in the 75th, 90th, 95th and 99th quantile and has a small positive influence on the joint occurences between the markets of Germany and Turkey. As expected the return of DAX on the other side is significant in all of the estimated quantiles with a positive influence on both negative and positive joint comovements. It captures big portion of both positive and negative shocks. The influence of DAX is almost the same in all of the examined quantiles. On the other hand volatility of DAX does not have any significant influence on any of the reported quantiles. As in the previous regression return of crude oil (Brent) and its volatility significant does not have any significance in the model on occurrence of coexceedances in any of the reported quantiles. The returns of USD/EUR exchange rate is not significant in any of the quantiles. Volatility of BIST is not significant in any of the quantiles. Lagged value of coexceedance between DAX and BIST is significant in all the reported quantiles and has a positive influence on the occurrence of both positive and negative comovements. We cannot conclude that the specified model explains the joint negative and positive occurrences between the markets of Germany and Turkey during the crisis as most of the used variables do not produce significant coefficients.

5.5.4 Germany – Macedonia during crisis

The results of Quantile regression of Model 2 from equation (5) of German and Montenegro stock market coexceedances during the financial crisis are in Appendix A in Table 9. The yield of 10 year German government bonds is significant in the 5th and 99th estimated quantiles. In both quantiles the German bond yield has a small positive influence on the comovements between markets. The price of 10 year Eurobonds is only significant in the very first quantile and has a small positive relationship on the negative coexceedances. Similarly to previous results the returns of DAX are not significant in any of the examined quantiles. The volatility of DAX, the volatility of Europe Brent spot price and the returns of USD/EUR exchange rate do not produce any significant coefficients in any of the estimated quantiles. The return of Europe

Brent spot price is significant in the 25th quantile but shows only very small positive relationship with the coexceedances. The volatility of MBI does not show any significance in any of the estimated quantiles. Lagged value of coexceedance between DAX and MBI is significant in all the reported quantiles and has a positive influence on all the comovements between markets. Like with the previous regression estimates, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Macedonia even during the financial crisis as most of the used variables do not produce significant coefficients.

5.5.5 Germany – Bosnia during crisis

The results of Quantile regression of Model 2 from equation (5) of German and Bosnian stock market coexceedances are in Appendix A in Table 10. The German 10 year bond yields produce significant coefficients in the 5th and 10th examined quantiles, however in line with the previous estimates they only show a very small positive relationship with the negative coexceedances. The 10 year Eurobond prices are significant only in the 10th quantile and have a very small positive effect on the negative coexceedances similarly to the previous estimations. Both returns of DAX and volatility of DAX have no significant effect on the market comovements. The same applies for Brent returns and Brent volatility as they also produce insignificant coefficients. Additionally also USD/EUR exchange rate returns are insignificant in all analyzed quantiles. Volatility of SASX does not have any effect on the co-exceedances as it is insignificant in all quantiles. Interestingly, lagged value of coexceedance between DAX and SASX has a positive effect on occurrence of co-exceedances, which was not the case with the estimation of the unrestricted sample. Again like with the previous regression estimates, we cannot conclude that the specified model explains the joint negative occurrences between the markets of Germany and Bosnia during the financial crisis as most of the used variables do not produce significant coefficients.

5.6 Contagion

5.6.1 Contagion from Germany to Montenegro

Even thought we do find the presence of joint positive and negative returns in the sample we cannot prove there is evidence of contagion from EU to Montenegro. Volatility of the Montenegro stock market did not increase after crisis, on the contrary the market seems to be stagnating after the turbulent period of crisis. We did not find almost any positive coexceedances between these two markets. There was a substantial amount of negative coexceedances between these two markets however they were not explained thoroughly by any of the explanatory variables which were included on the basis of previous literature and studies. We cannot conclude that there was contagion present between these two markets. We also do not find any evidence of contagion being stronger during the financial crisis period.

5.6.2 Contagion from Germany to Serbia

With very similar results to Montenegro, we can conclude that even thought we do find the presence of joint positive and negative returns in the sample we cannot prove there is evidence of contagion from EU to Serbia. The Serbian market was less volatile in the period after the crisis. Almost no positive coexceedances were present between these two markets. There was a substantial amount of negative coexceedances between these two markets however they were not explained thoroughly by any of the explanatory variables which we included on the basis of previous literature and studies. We cannot conclude that there was contagion present between these two markets. We also do not find any evidence of contagion being stronger during the financial crisis period.

5.6.3 Contagion from Germany to Turkey

We can conclude that even thought we do find the presence of joint positive and negative returns in the sample we cannot prove there is evidence of contagion from EU to Turkey. The most prevalent difference in the Turkish market was that there was

a sufficient number of positive coexceedances present between these two markets. There was also a substantial amount of negative coexceedances between these two markets. Just as in the case of previous markets they were not explained by any of the explanatory variables which we included on the basis of previous literature and studies. We cannot conclude that there was contagion present between these two markets. We also do not find any evidence of contagion being stronger during the financial crisis period.

5.6.4 Contagion from Germany to Macedonia

Like in the case of Montenegro or Serbia, we found almost no positive coexceedances between its market and the EU reference market. There was a fair amount of negative coexceedances present, however the evidence points to these only being comovements and not contagion. The coexceedances between these two markets were not explained thoroughly by any of the explanatory variables which we included into the quantile regression framework. We cannot conclude that there was contagion present between these two markets. We also do not find any evidence of contagion being stronger during the financial crisis period. Additionally, the market of Macedonia was less volatile in the period after the financial crisis.

5.6.5 Contagion from Germany to Bosnia

Bosnian market like three of the four other examined markets showed almost no positive coexceedances between its market and the reference EU market. There was a substantial amount of negative coexceedances between these two markets, however we can conclude that even thought we do find the presence of joint returns in the sample we cannot prove there is evidence of contagion from EU to Bosnia. The quantile regression estimates did not provide sufficient coefficients to explain the joint occurrence of extreme returns. Again, variables which we included were chosen on the basis of previous literature and studies. We cannot conclude that there was contagion present between these two markets. We also do not find any evidence of contagion being stronger during the financial crisis period.

5.6.6 Hypotheses

After the literature review we have formulated the following hypotheses of how the examined markets are likely to behave which we wanted to confirm or reject. First that there exists contagion between the countries with the possibility to enter the EU and the EU reference market. We reject this hypothesis as we did not find significante evidence to hold this statement. Secondly, that the contagion in the financial markets of these countries is predictable. Since we did not find evidence of contagion we also reject this hypothesis. Finally, that the coexceedance in financial markets of these countries is affected by stock returns volatility, interest and exchange rates. We reject this hypothesis on the basis of the quantile regression results which did not explain the comovements between markets to a sufficient extent.

6 Conclusion

In this thesis we analyze the topic of financial contagion in stock markets between a reference EU market represented by Germany and five countries which are actively seeking to become a part of the EU in the near future – Montenegro, Serbia, Turkey, Macedonia and Bosnia. We use the coexceedance framework of Bae et al. (2003) to investigate the joint occurrence of extreme stock returns. To assess the determinant factors and the extent of contagion we use quantile regression models similarly to Baur and Schulze (2005).

Our approach was applied to daily data ranging from March 2006 to February 2018. We bootstrapped the regression to obtain robust results. We used control variables such as Bond yields of German Government bonds, the returns and volatility of Europe Brent spot price (oil) and the price of 10 year corporate Eurobonds. We also used dummy variables to check if our results hold in various time periods. Additionally we restricted the regression to only the period of the crisis to find better evidence of contagion in the turbulent times of financial crises. Even though we found joint positive and negative coexceedances between the EU market and the examined markets we did not find evidence of financial contagion between them. We rejected the first hypothesis as we did not find significante evidence to hold the statement that contagion from the EU to our examined markets exists. We rejected the second hypothesis that the contagion in the financial markets of these countries is predictable since we did not find evidence of contagion. Finally we rejected the last hypothesis that the coexceedance in financial markets of these countries is affected by stock returns volatility, interest and exchange rates on the basis of the quantile regression results which did not explain the comovements between markets to a sufficient extent. It is very probable that even though we find many instances of coexceedances between these markets it is only a comovement and we cannot talk about contagion. The reason behind this might have to do with our main motivation to analyze this topic. We wanted to know if the market of EU and these non-EU markets are already interconnected to a sufficient extent to provide channels for contagion. It seems that the very reason for

the absence of contagion channels would be that these markets have yet to become member states of the EU and therefore more integrated into the financial markets of the EU.

We believe that this paper contributes to the existing literature by providing an analysis of contagion of markets which have not been interconnected historically however are with a big probability be interconnected in the future.

The topic of contagion from European Union to the markets of countries trying to become a part of the EU offers further possibility for research. First and foremost it could be expanded by using additional different explanatory variables that would better explain the coexceedances between EU and examined markets. It could be further expanded by incorporating multiple reference markets within the EU to the study.

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Appendix A: Estimates of Quantile regression

Table 1 Quantile regression estimates: coexceedances between Montenegro and German stock market					
	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)
germanbonds	0.136**	0.0498*	0.00711	0.0000236	-1.66e-15
	(3.29)	(2.11)	(1.62)	(0.08)	(-0.35)
eurobonds	0.0271***	0.00855**	0.00188***	0.0000247	-3.46e-16
	(5.69)	(2.70)	(3.55)	(0.31)	(-0.54)
daxreturns	-0.0173	0.335	0.270**	0.00403	4.23e-15
	(-0.05)	(1.43)	(2.72)	(0.30)	(0.61)
daxvar	-49.94	-29.05	-34.33	-0.561	1.57e-13
	(-0.73)	(-0.72)	(-1.48)	(-0.24)	(0.15)
eubrentreturns	-0.0686	-0.0616	0.00495	0.000100	-1.28e-15
	(-0.60)	(-0.81)	(0.21)	(0.07)	(-0.31)
eubrentvar	-13.87	-2.356	0.229	-0.150	3.39e-15
	(-0.84)	(-0.38)	(0.10)	(-0.45)	(0.01)
usdeurreturns	0.127	0.495	0.319**	0.00552	1.19e-15
	(0.17)	(1.65)	(2.61)	(0.30)	(0.11)
Dcrisis	0.0621	-0.187	-0.0778	-0.00306	8.03e-16
	(0.64)	(-1.83)	(-1.75)	(-1.63)	(0.33)
Daftercrisis	0.156*	-0.0273	-0.0286***	-0.000624	3.94e-15
	(2.01)	(-0.80)	(-4.12)	(-0.41)	(1.27)
monexvar	-0.350	-1.398*	-0.0719	0.000101	7.72e-16
	(-0.67)	(-2.22)	(-0.15)	(0.20)	(0.44)
lagdaxmonex	0.464***	0.901***	1.012***	1.027***	0.994***
	(5.23)	(12.15)	(73.71)	(218.18)	(293.81)
_cons	-3.887***	-1.141*	-0.225**	-0.00256	4.27e-14
	(-5.82)	(-2.45)	(-3.15)	(-0.28)	(0.50)

N	2840	2840	2840	2840	2840
t statistics in parentheses					
="* p<0.05	** p<0.01	*** p<0.001"			

Source: Author´s computations based on equation (4)

Table 2 Quantile regression estimates: coexceedances between Serbian and German stock market				
	quantile (1)	quantile (5)	quantile (10)	quantile (25)
germanbonds	0.0364***	0.00553*	0.000497	1.52e-14
	(4.24)	(2.26)	(0.61)	(0.00)
eurobonds	0.00519***	0.00102**	0.000245	2.58e-15
	(4.26)	(2.82)	(1.61)	(0.00)
daxreturns	0.404**	0.176**	0.0717	-3.54e-14
	(2.78)	(3.00)	(1.81)	(-0.00)
daxvar	10.38	-11.86	-2.910	4.75e-12
	(1.09)	(-1.69)	(-0.62)	(0.00)
eubrentreturns	-0.0211	0.00270	0.000258	-8.22e-15
	(-0.45)	(0.21)	(0.06)	(-0.00)
eubrentvar	2.320	0.451	0.0496	6.00e-13
	(1.29)	(0.66)	(0.17)	(0.00)
usdeurreturns	0.511*	0.258**	0.0687	-1.82e-14
	(2.57)	(3.08)	(1.57)	(-0.00)
Dcrisis	-0.00510	-0.0121**	-0.00911***	-0.00523***
	(-0.50)	(-2.72)	(-3.47)	(-4.02)
Daftercrisis	-0.0245	-0.0104*	-0.00550*	-2.12e-14
	(-1.90)	(-2.52)	(-2.19)	(-0.00)
belextvar	-17.42**	-6.883	-5.568	7.55e-13
	(-2.81)	(-1.11)	(-1.27)	(0.00)
lagdaxbelex	0.989***	1.024***	1.023***	1.014***
	(33.86)	(71.78)	(143.25)	(837.22)
_cons	-0.705***	-0.130**	-0.0276	-3.30e-13
	(-4.37)	(-2.70)	(-1.45)	(-0.00)
N	2866	2866	2866	2866

Source: Author´s computations based on equation (4)

Table 3 Quantile regression estimates: coexceedances between Turkish and German stock market

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)	quantile (90)	quantile (95)	quantile (99)
germanbonds	-0.0136	0.00136	0.00158	0.00113	0.000888	-0.000536	0.000575	0.000749	-0.00545
	(-1.13)	(0.32)	(0.54)	(0.63)	(0.59)	(-0.25)	(0.20)	(0.17)	(-0.56)
eurobonds	-0.00170	-0.0000755	0.000244	0.000133	0.000297	0.000207	0.000264	0.000307	0.000467
	(-1.40)	(-0.18)	(0.83)	(0.80)	(1.90)	(0.92)	(0.86)	(0.61)	(0.35)
daxreturns	2.080***	1.978***	2.085***	2.119***	2.119***	2.188***	2.116***	2.104***	1.956***
	(8.72)	(16.73)	(27.98)	(29.50)	(36.62)	(37.89)	(17.77)	(16.25)	(7.78)
daxvar	-18.44	-26.41	-16.51	0.429	-0.708	-0.196	10.77	14.26	32.79
	(-0.85)	(-1.44)	(-1.05)	(0.15)	(-0.56)	(-0.04)	(0.98)	(1.37)	(1.45)
eubrentreturns	0.0846	0.0552	-0.0237	-0.0396	-0.00344	-0.0159	0.0107	-0.0235	-0.0142
	(0.75)	(0.88)	(-0.61)	(-1.79)	(-0.33)	(-0.84)	(0.26)	(-0.39)	(-0.13)
eubrentvar	1.811	-1.105	0.0177	0.596	0.175	-0.569	-0.120	3.353	-6.223
	(0.19)	(-0.23)	(0.00)	(0.33)	(0.26)	(-0.27)	(-0.04)	(0.65)	(-0.51)
usdeurreturns	-0.519	-0.176	-0.0371	-0.0189	-0.0915*	-0.158	0.0777	0.338	0.513
	(-1.24)	(-0.74)	(-0.25)	(-0.22)	(-2.15)	(-1.78)	(0.43)	(1.79)	(1.28)
Dcrisis	-0.0519**	-0.0207**	-0.0162***	-0.00621*	0.000383	0.00816**	0.0203***	0.0335***	0.0316*
	(-3.17)	(-2.82)	(-4.90)	(-2.52)	(0.23)	(3.28)	(4.28)	(4.71)	(2.21)
Daftercrisis	-0.0544**	-0.0192*	-0.0196***	-0.00634	-0.00172	0.00525	0.0223***	0.0299***	0.0330*
	(-2.58)	(-2.03)	(-3.96)	(-1.94)	(-0.81)	(1.92)	(3.58)	(3.73)	(2.35)
bisttvar	-69.52	3.338	1.672	-0.213	0.525	2.288	-2.478	-3.977	-21.90
	(-1.75)	(0.21)	(0.16)	(-0.08)	(0.25)	(0.81)	(-0.61)	(-0.82)	(-1.20)
lagdaxbist	0.977***	0.984***	0.989***	0.994***	0.999***	1.005***	1.006***	1.009***	1.001***
	(104.19)	(273.87)	(431.01)	(792.33)	(1148.83)	(909.52)	(413.75)	(203.87)	(89.35)
_cons	0.212	-0.0192	-0.0459	-0.0270	-0.0351	-0.0128	-0.0177	-0.0192	0.00856
	(1.25)	(-0.33)	(-1.13)	(-1.14)	(-1.60)	(-0.40)	(-0.42)	(-0.28)	(0.05)
N	2839	2839	2839	2839	2839	2839	2839	2839	2839
t statistics in parentheses									
="* p<0.05	** p<0.01	*** p<0.001"							

Source: Author´s computations based on equation (4)

Table 4 Quantile regression estimates: coexceedances between Macedonian and German stock market

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)
germanbonds	0.0234*	-0.000546	-0.000619	1.54e-15	-2.82e-15
	(2.53)	(-0.29)	(-1.02)	(0.30)	(-0.61)
eurobonds	0.00360**	0.000399	0.0000236	1.68e-16	-6.15e-16
	(3.20)	(1.66)	(0.65)	(0.21)	(-0.85)
daxreturns	0.427***	0.136*	0.0212	-1.36e-15	7.29e-15
	(4.12)	(2.47)	(1.42)	(-0.14)	(0.82)
daxvar	-10.96	-4.248	-0.855	2.51e-13	-1.90e-12
	(-0.55)	(-0.82)	(-0.82)	(0.13)	(-1.02)
eubrentreturns	-0.0186	0.00366	0.00114	5.65e-16	5.50e-15
	(-0.33)	(0.35)	(0.65)	(0.11)	(1.16)
eubrentvar	2.823	-0.0102	-0.0468	-4.76e-13	-3.06e-13
	(0.60)	(-0.01)	(-0.28)	(-1.43)	(-0.88)
usdeurreturns	0.551*	0.124	0.0238	3.66e-15	1.15e-14
	(2.11)	(1.61)	(1.40)	(0.25)	(0.87)
Dcrisis	-0.0218	-0.0147***	-0.00829***	-0.00169	5.47e-15*
	(-1.87)	(-3.84)	(-3.91)	(-1.26)	(2.06)
Daftercrisis	-0.0206**	-0.0140***	-0.00301	1.62e-15	8.71e-15
	(-3.10)	(-3.69)	(-1.33)	(0.31)	(1.73)
mbivar	4.212	0.562	-0.360	1.59e-14	-5.52e-13
	(1.88)	(0.21)	(-0.77)	(0.02)	(-0.89)
lagdaxmbi	1.005***	1.042***	1.038***	1.019***	1.000***
	(38.89)	(83.55)	(161.15)	(626.12)	(1096.43)
_cons	-0.489**	-0.0419	-0.000137	-2.45e-14	7.49e-14
	(-3.11)	(-1.29)	(-0.03)	(-0.23)	(0.79)
N	2792	2792	2792	2792	2792
t statistics in parentheses					
="* p<0.05	** p<0.01	*** p<0.001"			

Source: Author´s computations based on equation (4)

Table 5 Quantile regression estimates: coexceedances between Bosnian and German stock market				
	quantile (1)	quantile (5)	quantile (10)	quantile (25)
germanbonds	0.0180	0.00352	-2.58e-15	-0.000000113
	(1.92)	(1.89)	(-0.00)	(-0.48)
eurobonds	0.00348**	0.000836***	-2.50e-16	-1.63e-08
	(2.74)	(4.39)	(-0.00)	(-0.62)
daxreturns	0.140	0.0436	5.52e-16	0.0000170
	(1.02)	(1.84)	(0.00)	(1.72)
daxvar	4.694	0.613	1.45e-13	0.00291
	(0.77)	(0.63)	(0.00)	(1.75)
eubrentreturns	-0.0103	-0.00118	6.47e-16	-0.00000406
	(-0.37)	(-0.25)	(0.00)	(-1.72)
eubrentvar	0.0242	0.404	-1.82e-14	0.000421
	(0.01)	(1.14)	(-0.00)	(1.53)
usdeurreturns	0.340	0.0813	-7.09e-15	0.0000282
	(1.32)	(1.65)	(-0.00)	(1.70)
Dcrisis	0.00821	0.00237	-0.000116	-0.000258
	(0.27)	(0.83)	(-0.16)	(-0.67)
Daftercrisis	-0.0412***	-0.0127**	-3.13e-15	-0.000000551
	(-3.53)	(-2.79)	(-0.00)	(-1.44)
sasxvar	0.162	0.0620	2.82e-15	-0.0200*
	(0.38)	(0.39)	(0.00)	(-2.15)
lagdaxsasx	1.035***	1.030***	1.021***	1.006***
	(25.42)	(115.25)	(384.75)	(1153.93)
_cons	-0.445**	-0.103***	3.77e-14	0.00000334
	(-2.59)	(-3.94)	(0.00)	(0.87)
N	2828	2828	2828	2828
t statistics in parentheses				
="* p<0.05	** p<0.01	*** p<0.001"		

Source: Author´s computations based on equation (4)

Table 6 Quantile regression estimates: coexceedances between Montenegro and German stock market during the crisis

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)
germanbonds	-0.00556	0.363*	0.328*	0.0535	0.00891	0.0362
	(-0.03)	(2.05)	(2.50)	(0.72)	(0.56)	(1.08)
eurobonds	0.0282*	0.0406***	0.0394***	0.00523	0.000682	0.00259
	(2.43)	(4.28)	(3.90)	(0.74)	(0.52)	(1.46)
daxreturns	2.270	1.922	0.00657	0.0370	0.0389	0.0157
	(1.03)	(1.30)	(0.01)	(0.23)	(0.45)	(0.08)
daxvar	-86.23	-2.424	4.158	-6.469	-8.892	-12.97
	(-0.68)	(-0.03)	(0.07)	(-0.29)	(-1.56)	(-1.03)
eubrentreturns	-1.882	0.573	-0.0632	0.00165	0.00419	0.0174
	(-1.13)	(0.61)	(-0.10)	(0.01)	(0.06)	(0.10)
eubrentvar	33.80	38.54	16.03	-0.663	-0.469	-2.398
	(0.72)	(1.64)	(1.20)	(-0.11)	(-0.11)	(-0.23)
usdeurreturns	-4.366	-8.640*	-1.010	-0.0447	-0.0915	0.172
	(-0.75)	(-2.13)	(-0.45)	(-0.13)	(-0.51)	(0.31)
monexvar	-0.182	-0.631	-1.060	0.0435	0.0129	0.508*
	(-0.21)	(-1.09)	(-1.75)	(0.12)	(0.11)	(2.10)
lagdaxmonex	0.286	0.465***	0.405*	0.946***	0.974***	0.718***
	(1.55)	(3.51)	(2.55)	(8.44)	(40.11)	(6.45)
_cons	-3.532*	-5.818***	-5.429***	-0.743	-0.101	-0.391
	(-2.51)	(-5.10)	(-3.77)	(-0.73)	(-0.53)	(-1.35)
N	395	395	395	395	395	395
t statistics in parentheses						
="* p<0.05	** p<0.01	*** p<0.001"				

Source: Author´s computations based on equation (5)

Table 7 Quantile regression estimates: coexceedances between Serbian and German stock market during the crisis

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)	quantile (90)	quantile (95)	quantile (99)
germanbonds	0.0137	0.0158	0.0279*	0.0237**	0.0224***	0.0230**	0.00561	0.00192	-0.0481
	(0.46)	(0.75)	(2.21)	(2.71)	(3.67)	(2.86)	(0.33)	(0.07)	(-1.25)
eurobonds	0.00489**	0.00399**	0.00298***	0.00151**	0.00133**	0.00143**	0.000111	-0.00196	-0.00451*
	(2.85)	(3.15)	(3.53)	(2.67)	(3.16)	(3.07)	(0.09)	(-1.18)	(-2.28)
daxreturns	0.323	0.0784	0.0119	0.0361	0.00928	0.0439	0.219	0.617	0.929**
	(1.80)	(0.65)	(0.16)	(0.47)	(0.15)	(0.49)	(0.82)	(1.83)	(2.80)
daxvar	6.668	0.169	-12.63	-9.354	-5.411	-2.795	-6.928	-13.99	-23.38*
	(0.42)	(0.01)	(-1.44)	(-1.26)	(-0.97)	(-0.45)	(-0.79)	(-1.55)	(-2.04)
eubrentreturns	-0.0394	0.00113	-0.0214	-0.0583	-0.000702	0.0146	0.0304	-0.0956	-0.388
	(-0.39)	(0.02)	(-0.48)	(-1.33)	(-0.02)	(0.24)	(0.34)	(-0.70)	(-1.95)
eubrentvar	3.875	3.230	2.487	1.451	-0.192	-1.284	-0.554	-0.818	-4.600
	(1.05)	(1.25)	(1.79)	(1.03)	(-0.21)	(-0.96)	(-0.19)	(-0.18)	(-0.90)
usdeurreturns	-0.126	0.102	0.0763	0.247	0.208	0.268	0.599	0.893	1.162
	(-0.31)	(0.38)	(0.39)	(1.66)	(1.71)	(1.82)	(1.57)	(1.87)	(1.80)
belextvar	-7.918	-10.15	-6.860	-4.166	0.991	2.630	3.171	3.367	9.619
	(-1.46)	(-1.77)	(-1.29)	(-0.90)	(0.42)	(1.62)	(1.18)	(0.94)	(1.85)
lagdaxbelex	0.896***	0.920***	0.938***	0.976***	0.975***	0.966***	1.000***	1.022***	1.008***
	(24.33)	(32.60)	(49.15)	(82.39)	(120.71)	(102.38)	(56.44)	(45.14)	(33.01)
_cons	-0.642*	-0.528**	-0.445***	-0.252**	-0.222***	-0.229**	-0.00636	0.244	0.692*
	(-2.35)	(-2.78)	(-3.44)	(-2.88)	(-3.41)	(-3.05)	(-0.04)	(0.97)	(2.14)
N	397	397	397	397	397	397	397	397	397
t statistics in parentheses									
="* p<0.05	** p<0.01	*** p<0.001"							

Source: Author´s computations based on equation (5)

Table 8 Quantile regression estimates: coexceedances between Turkish and German stock market during the crisis

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)	quantile (90)	quantile (95)	quantile (99)
germanbonds	-0.0149	-0.0211*	-0.0153	-0.00531	-0.000841	0.00440	0.0174*	0.0327***	0.0594***
	(-0.69)	(-2.39)	(-1.69)	(-1.47)	(-0.52)	(1.77)	(2.43)	(4.09)	(3.73)
eurobonds	-0.00493	-0.00576***	-0.00349*	-0.000871	0.000595	0.00233***	0.00506***	0.00799***	0.0137***
	(-1.65)	(-4.20)	(-2.31)	(-1.46)	(1.76)	(4.82)	(3.94)	(4.47)	(5.30)
daxreturns	1.768***	1.918***	1.896***	1.916***	1.961***	1.941***	1.909***	1.878***	1.646***
	(8.32)	(18.19)	(24.20)	(51.43)	(78.43)	(54.87)	(25.56)	(16.97)	(9.37)
daxvar	1.335	2.510	-1.386	-2.602	-0.723	-1.706	-1.308	-7.267	-15.90
	(0.21)	(0.58)	(-0.28)	(-1.53)	(-0.48)	(-0.90)	(-0.33)	(-1.21)	(-1.76)
eubrentreturns	0.110	0.0553	0.0128	0.0207	0.00526	-0.00635	-0.00730	0.0220	0.0916
	(1.14)	(1.13)	(0.43)	(1.43)	(0.60)	(-0.41)	(-0.25)	(0.46)	(1.67)
eubrentvar	4.496*	2.231	-0.852	-0.106	0.221	-0.159	0.747	-0.0355	2.625
	(2.31)	(1.29)	(-0.50)	(-0.17)	(0.58)	(-0.15)	(0.29)	(-0.01)	(0.41)
usdeurreturns	0.212	-0.0281	-0.00186	-0.0290	-0.0382	0.000339	-0.0222	0.0134	0.114
	(1.12)	(-0.25)	(-0.02)	(-0.64)	(-1.49)	(0.01)	(-0.23)	(0.08)	(0.46)
bisttvar	6.316	-2.682	5.257	3.574	2.523	2.870	-5.218	6.905	14.70
	(0.56)	(-0.28)	(0.69)	(1.09)	(0.86)	(0.70)	(-0.56)	(0.50)	(0.57)
lagdaxbist	0.984***	1.011***	0.998***	0.994***	0.997***	1.000***	0.991***	0.966***	0.919***
	(35.09)	(87.56)	(81.74)	(198.09)	(337.43)	(224.14)	(75.00)	(59.07)	(29.87)
_cons	0.485	0.642***	0.387*	0.0927	-0.0616	-0.242***	-0.562***	-0.934***	-1.638***
	(1.21)	(4.08)	(2.05)	(1.25)	(-1.62)	(-4.16)	(-3.54)	(-4.47)	(-5.04)
N	390	390	390	390	390	390	390	390	390
t statistics in parentheses									
="* p<0.05	** p<0.01	*** p<0.001"							

Source: Author´s computations based on equation (5)

Table 9 Quantile regression estimates: coexceedances between Macedonian and German stock market during the crisis

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)	quantile (90)	quantile (95)	quantile (99)
germanbonds	0.0207	0.0629**	0.01000	0.00501	0.00185	0.00925	0.0251*	0.0482*	0.0830***
	(0.52)	(2.61)	(0.60)	(1.25)	(0.60)	(1.75)	(2.16)	(2.14)	(3.39)
eurobonds	0.00622**	0.00483	0.000243	0.000129	0.000107	0.000695*	0.00148*	0.00199	-0.000790
	(2.91)	(1.74)	(0.15)	(0.44)	(0.52)	(2.00)	(2.42)	(1.56)	(-0.45)
daxreturns	0.303	-0.0566	0.00820	0.0141	0.000944	0.0131	0.0539	0.00183	0.146
	(0.90)	(-0.29)	(0.09)	(0.45)	(0.06)	(0.44)	(0.70)	(0.01)	(0.78)
daxvar	2.726	3.024	0.0206	0.250	0.279	1.070	-0.431	-3.842	-22.63*
	(0.12)	(0.18)	(0.00)	(0.12)	(0.32)	(0.63)	(-0.13)	(-0.57)	(-1.98)
eubrentreturns	0.0478	0.142	0.136*	0.0854**	0.0119	0.0411	0.0663	0.102	0.112
	(0.22)	(1.17)	(2.00)	(3.08)	(0.81)	(1.52)	(1.16)	(1.38)	(1.00)
eubrentvar	14.71	3.384	1.898	-0.704	-0.652	-0.454	-3.775*	-6.360	-10.02*
	(1.48)	(0.41)	(0.48)	(-0.40)	(-0.57)	(-0.35)	(-1.99)	(-1.87)	(-2.00)
usdeurreturns	-0.0379	-0.127	-0.189	-0.161	-0.0239	-0.0499	-0.0966	-0.108	-0.103
	(-0.06)	(-0.24)	(-0.73)	(-1.70)	(-0.61)	(-0.67)	(-0.46)	(-0.32)	(-0.21)
mbivar	-0.569	2.006	-1.470	-0.707	0.0447	0.625	2.434	-0.898	3.930
	(-0.05)	(0.33)	(-0.44)	(-0.46)	(0.11)	(0.34)	(0.53)	(-0.10)	(0.38)
lagdaxmbi	0.907***	0.940***	1.024***	1.018***	0.995***	0.967***	0.926***	0.892***	0.953***
	(21.34)	(20.96)	(34.21)	(90.67)	(226.67)	(120.82)	(61.50)	(31.94)	(28.88)
_cons	-0.794*	-0.751*	-0.0704	-0.0325	-0.0174	-0.103	-0.232*	-0.353*	-0.143
	(-2.32)	(-2.02)	(-0.31)	(-0.75)	(-0.54)	(-1.94)	(-2.38)	(-2.20)	(-0.70)
N	385	385	385	385	385	385	385	385	385
t statistics in parentheses									
="* p<0.05	** p<0.01	*** p<0.001"							

Source: Author´s computations based on equation (5)

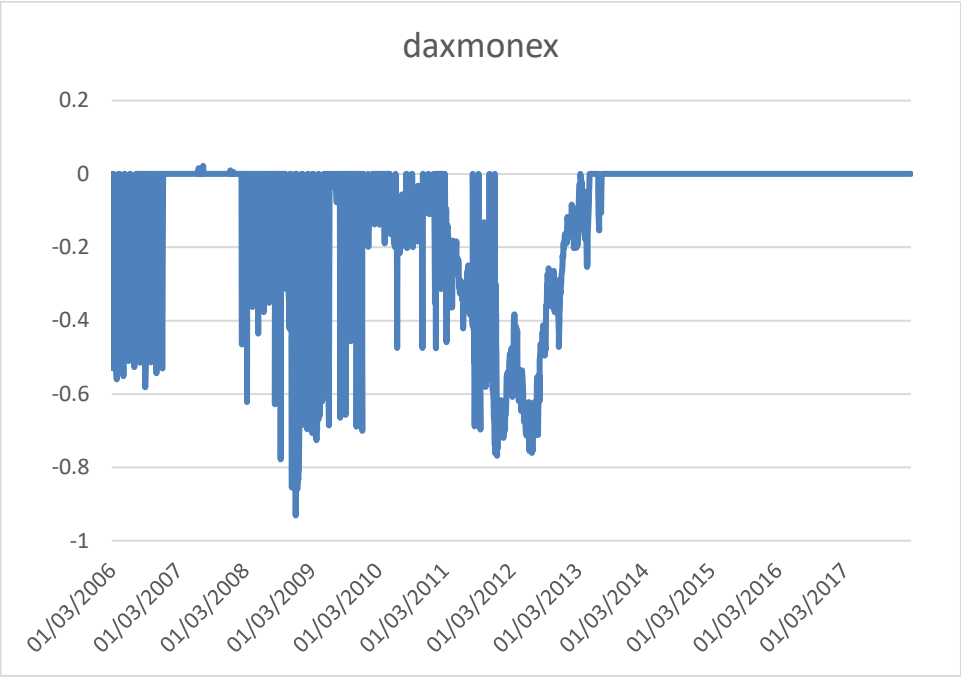
Table 10 Quantile regression estimates: coexceedances between Bosnian and German stock market during the crisis

	quantile (1)	quantile (5)	quantile (10)	quantile (25)	quantile (50)	quantile (75)	quantile (90)	quantile (95)	quantile (99)
germanbonds	-0.000686	0.00918**	0.00878**	0.000883	0.0000395	0.000173	0.000325	0.000391	0.000409
	(-0.03)	(2.73)	(3.28)	(0.76)	(0.24)	(0.97)	(1.03)	(1.02)	(0.37)
eurobonds	0.000811	0.000723*	0.000705**	0.000291	0.0000252	-0.000266	-0.000577	-0.000843*	-0.00157*
	(0.49)	(2.03)	(3.16)	(1.92)	(0.34)	(-1.40)	(-1.83)	(-2.31)	(-2.14)
daxreturns	-1.052	-0.0576	0.00906	0.00209	0.000132	-0.000619	-0.00642	-0.0155	-0.0187
	(-1.43)	(-0.44)	(0.32)	(0.28)	(0.17)	(-0.22)	(-0.85)	(-1.66)	(-0.84)
daxvar	0.656	-0.416	0.477	0.122	0.0162	-0.170	-0.341	-0.513	-0.984
	(0.06)	(-0.24)	(0.57)	(0.35)	(0.45)	(-1.03)	(-0.98)	(-1.07)	(-0.38)
eubrentreturns	-0.176	-0.0332	-0.0197	-0.00281	-0.0000290	-0.000185	0.00142	0.00156	-0.00525
	(-1.01)	(-0.81)	(-0.88)	(-0.48)	(-0.05)	(-0.19)	(0.44)	(0.39)	(-0.45)
eubrentvar	1.986	0.404	0.451	0.0617	0.000397	-0.00105	-0.0217	-0.0560	-0.110
	(0.30)	(0.64)	(1.27)	(0.70)	(0.06)	(-0.05)	(-0.46)	(-0.49)	(-0.50)
usdeurreturns	1.244	0.196	0.106	-0.00355	0.000144	-0.00433	-0.0117	0.00608	-0.00729
	(1.57)	(1.05)	(1.33)	(-0.16)	(0.04)	(-0.94)	(-0.76)	(0.26)	(-0.15)
sasxvar	0.000391	0.0327	0.0132	-0.00952	-0.0353	-0.0675	-0.102	-0.130	-0.180
	(0.00)	(0.02)	(0.01)	(-0.02)	(-0.16)	(-0.12)	(-0.11)	(-0.12)	(-0.12)
lagdaxsasx	0.895***	1.007***	1.008***	1.011***	1.001***	0.987***	0.972***	0.961***	0.938***
	(11.91)	(93.65)	(144.62)	(263.64)	(544.60)	(225.68)	(165.18)	(144.44)	(66.69)
_cons	-0.161	-0.113**	-0.107***	-0.0325*	-0.00262	0.0259	0.0566	0.0833*	0.157*
	(-0.71)	(-2.79)	(-3.80)	(-1.98)	(-0.34)	(1.40)	(1.83)	(2.31)	(2.16)
N	374	374	374	374	374	374	374	374	374
t statistics in parentheses									
="* p<0.05	** p<0.01	*** p<0.001"							

Source: Author´s computations based on equation (5)

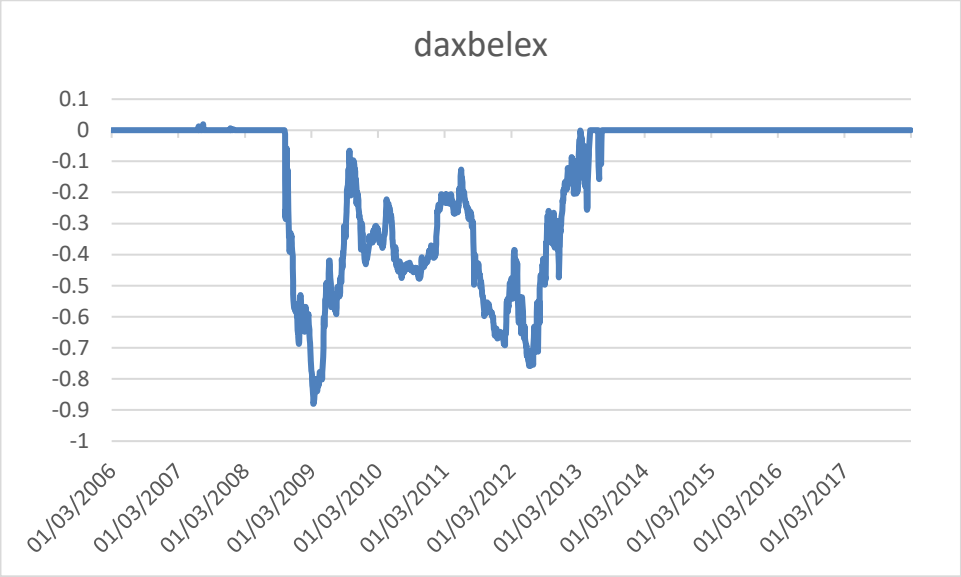
Appendix B: Coexceedances between stock markets

Figure 1 Coexceedances between Montenegro and German stock exchange



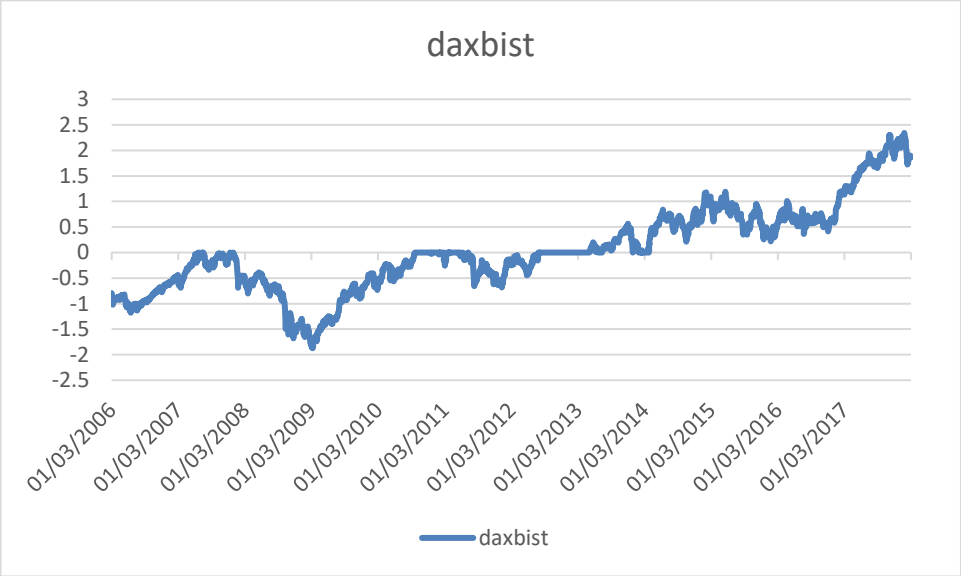
Source: Author´s computations

Figure 2 Coexceedances between Serbian and German stock exchange



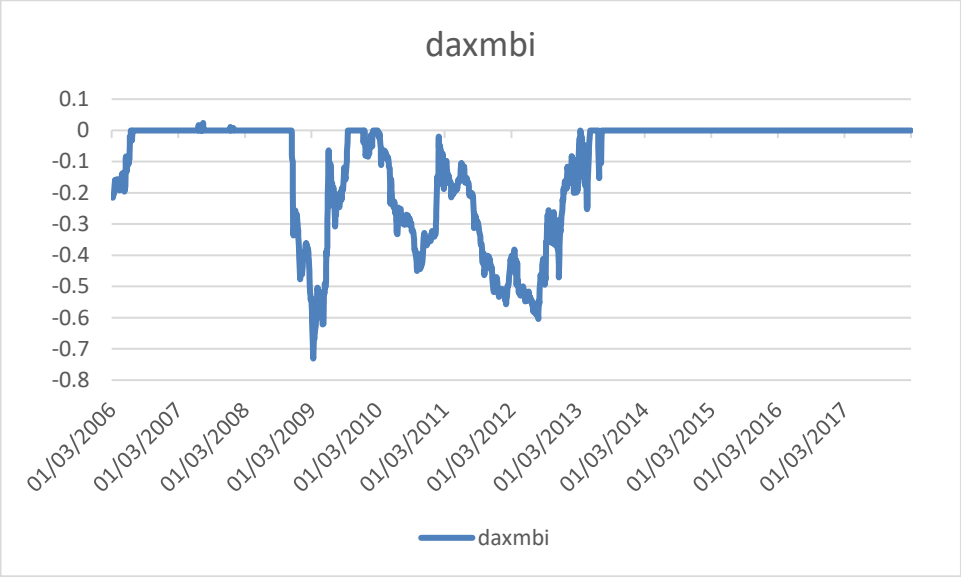
Source: Author´s computations

Figure 3 Coexceedances between Turkish and German stock exchange



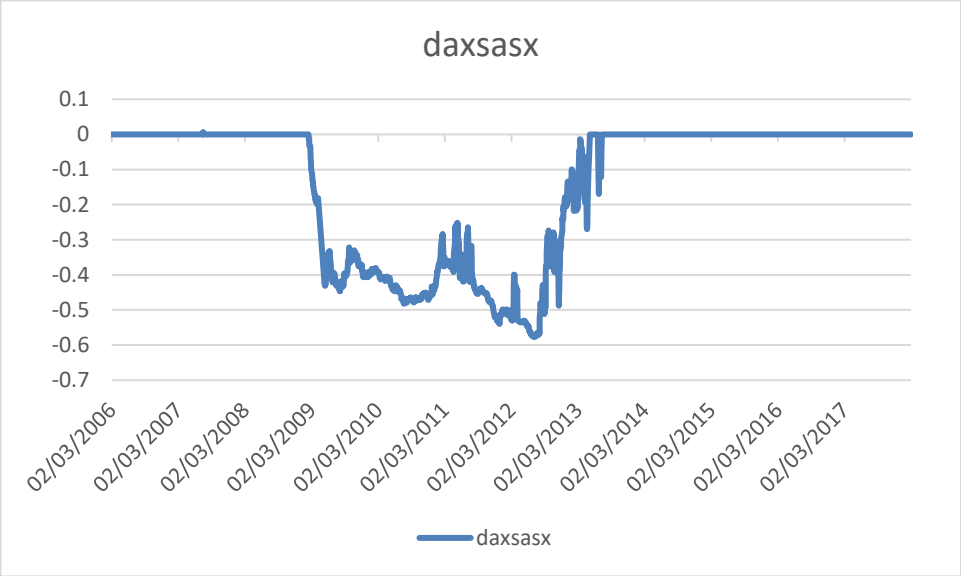
Source: Author´s computations

Figure 4 Coexceedances between Macedonian and German stock exchange



Source: Author´s computations

Figure 5 Coexceedances between Bosnian and German stock exchange



Source: Author´s computations