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COMOVEMENTS OF FINANCIAL MARKETS IN EU COUNTRIES

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Research Master's Thesis

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Foreword

This Master thesis is written as the final result of Double Degree Master in Louvain School of Management in Belgium and Vytautas Magnus University in Lithuania. The thesis is expected to add value in financial literature by providing new insights in the field investigated.

This Master thesis would not have been implemented without every single person, who added their part in the process of writing it. I would like to thank prof. V. Darskuviene and prof. P. Semal, who created the possibility to study in Double Degree program and made their best in organizing it. I would also like to thank my supervisor at Vytautas Magnus University, prof. K. Levisauskaite, who put so much efforts for implementation of this thesis and for my supervisor at Louvain School of Management, prof. L. Iania, for his consultations and wide collaboration in the process of the thesis. Finally, I am very thankful for my family, whose unconditional love and support encourages and motivates me in every single step of my life.

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Abstract

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The aim of Master thesis is to assess the strength of the comovements between stock, bond and stock-bond markets in EU countries. This thesis consists of three parts. The first part includes the valuation of international diversification as investment strategy and investigation of characteristics of stock and bond markets together with the analysis of previous researches of comovements between these markets. The methodology for investigation of comovements between stock, bond and stock-bond markets in EU countries together with the analysis and limitations of data is provided in the second part of the thesis. The results of investigation of comovements between financial markets and their statistical significance are provided in the third part of the thesis. It is revealed that the comovements between stock, bond and stock-bond markets in EU countries are weaker than they were expected to be. Nevertheless it was proven that the comovements between financial markets tend to strengthen in times of financial crisis.

Santrauka

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INTRODUCTION

Relevance. Integration of financial markets is the central topic when talking about international finance. Cross-country integration between particular financial asset markets (such as stock markets) has been analyzed widely but integration across different financial asset markets, despite of its significance to investors when taking asset allocation and risk management decisions, lacks attention in academic literature. As the main asset classes, reflecting long term investment decisions, should be named stock and bond markets. During the last decades portfolios concluded from stocks and bonds increased their popularity among investors not only due to different risk-return characteristics. It is also believed that their prices either move to opposite directions or have no connection. The fact that correlation between bonds and stocks has gained a vital role in portfolio allocation decisions made a timely determination of this correlation a question of high importance. Multiple authors tried to answer this question (Li, 2002; Ilmanen, 2003; Kim et al, 2006; Baur and Lucey, 2008; Yang et al, 2008; Baele et al, 2009) and came up with evaluation of comovements between different asset class indices in the major financial markets. The understanding of these comovements not only helps to improve the markets' efficiency but also to elevate the information congregation process, accelerate capital allocation functions and increase resilience in times of financial stress in the market. Finally, it also helps investors to diversify their investments between two main asset classes in order to reduce the overall risk. Even though this reduction is commonly implemented by diversifying portfolio between international markets, an alternative to that is diversification between asset classes. Here the key input is the determination of correlation between the same asset class in different countries and between different asset classes in the same country.

Problem. International or regional diversification and diversification between two main asset classes are usually referred to be the main investment strategies. It's widely thought that correlation between different countries or between assets with different risk-return characteristics is not strong enough providing an opportunity to benefit from diversification. This might be an idea during the whole business cycle, but previous researchers (Scruggs and Glabadanidis, 2003; Andersson et al, 2004; Cappiello et al, 2006; Baele et al, 2009) found that the relation between the assets is very unstable and tend to change its direction in times of financial turmoil. The recent financial crisis together with the following European sovereign debt crisis revealed that comovements between financial markets might be much stronger than they were expected to be. A question of big significance is whether it is still possible managing investment portfolio to effectively regionally diversify or diversify between different asset classes in the same country. A correct answer to this question should help to choose the right investment policy and to avoid big losses.

The **novelty of the research** comes from the fact that most of the previous researches in stock and bond markets only covered the US as being the strongest world's economy and several other

major countries (usually G7). None of the previous researchers analyzed the comovements between stock, bond and stock-bond markets of all European Union (EU) countries, so the amplitude of this research makes it important. Furthermore, there is a novelty in methodology. The research includes evaluation of comovements inside stock, bond markets and between these markets in separate countries and creation of correlation matrices. Finally, the evaluation of comovements between stock and bond markets is implemented by using several different methods and periods.

The object of the research is stock and bond markets of EU countries.

The aim of the research is to examine the comovements between stock, bond and stock-bond markets in EU countries and to provide an insight about the benefits of regional diversification and diversification between asset classes during the whole economic cycle and in time of financial stress.

To reach the aim of the research the following objectives are raised:

1. To analyze and synthesize the previous studies of stock and bond markets and comovements between them.
2. To estimate the value changes and volatility of stock and bond market indices of EU countries during the research period.
3. To come up with methodology for investigation of comovements between stock, bond and stock-bond markets in EU countries.
4. To estimate comovements between stock markets of EU countries.
5. To estimate comovements between bond markets of EU countries.
6. To estimate comovements between stock and bond markets of EU countries.
7. To investigate comovements between stock and bond markets of EU countries in the period of financial crisis and to compare them with comovements in the full sample period.
8. To provide recommendations for regional portfolio diversification and diversification between asset classes in the same country.

Research hypotheses:

1. The relationship between returns on main stock indices in the financial markets of EU countries is strong.
2. The relationship between returns on main government bond indices in the financial markets of EU countries is strong.
3. The relationship between returns on main stock and government bond indices in the financial markets of EU countries is strong.
4. The relationship between returns on main stock and government bond indices in the financial markets of EU countries became stronger in the period of financial crisis from 2008.

The structure of the thesis

This paper is divided into three parts.

The first part of the paper is devoted to the theoretical framework which supports the background of the research. Firstly, the modern financial markets and the concept of diversification are introduced. It also includes the analysis of previous researches of the inter-market relationships between stocks and bonds. Secondly, it is dedicated for the research methods and evaluation of the previous studies of stock-bond comovements with concentration on flight-to-quality phenomenon in times of financial crisis and the discussion of the results obtained. Thirdly, the situation of European Union's financial markets during the last 20 years is introduced by highlighting the period of financial crisis starting from 2008.

The second part of the paper is aimed to determine the methodology for evaluation of comovements between stock markets, bond markets and stock-bond markets in EU countries. This is done by analyzing the data collected and coming up with statistical estimations for implementation of the research.

The third part of the paper provides the calculations of statistical measures of comovements between financial markets and the analysis of the results obtained.

The last part of the paper provides the conclusions and the answers to research questions.

Methods and sources: The qualitative analysis and investigation of the main object is implemented by analyzing and synthesizing scientific literature and comparing the results obtained by previous researches in the same field. The main sources used for qualitative data collection are *Social Science Research Network (SSRN)*, *Science Direct*, *EBSCO* databases and literature available on the topic investigated. The quantitative research of stock and bond markets is implemented by using mathematical and statistical functions: calculation of logarithmic returns, volatility estimation with standard deviation, evaluation of distribution with skewness and kurtosis, calculation of correlation coefficients and evaluation of their statistical significance by testing the Fisher's null hypothesis. The main sources used for quantitative data are *Thomson Reuter's*, *World Bank's* and *Federation of European Securities Exchange* (FESE) databases. The research is implemented by using *Microsoft Office 2013* and *Statistical Package for Social Sciences (SPSS)* programs.

Research covers 20 year **period** from 1993 to 2013.

Practical implications: The paper is intended to be beneficial for investors when choosing regional diversification between EU countries and between asset classes in the same EU country.

Keywords: government bond indices, stock indices, comovements, financial crisis, European Union.

I. COMOVEMENTS BETWEEN FINANCIAL MARKETS AND POSSIBILITIES FOR INVESTMENT DIVERSIFICATION

1.1. The Role of Global Diversification

Financial markets are highly competitive. Due to this fact the returns investors expect to gain can rarely be predicted precisely. In the end, there should always be a risk-return trade-off in the securities markets, with higher-risk assets priced to offer higher expected returns than lower-risk assets (Cappiello et al, 2006; Bodie et al, 2009).

Diversification has become the head stone in modern finance. It was already proven by various authors that international portfolio diversification is a good investment strategy (Solnik, 2000; Reilly and Brown, 2006; Kim, Moshirian and Wu, 2006). The basic arguments for international portfolio diversification are that foreign investments offer additional profit potentials while reducing the total risk of the portfolio, so it helps to improve the risk-adjusted performance of a domestic portfolio (Cappiello et al, 2006). B. Solnik (2000) adds that domestic securities tend to move up and down together due to the same domestic conditions and this creates a strong positive correlation between national securities traded in the same market, applied equally to stocks and bonds. E. S. Lim et al (1998), J. Yang (2004), C. Ciner (2007) agree that transmission of information in global financial markets has increased significantly in recent decades due to elimination of barriers in capital movements. If a wider range of investment choices can benefit investors, there is no need to limit themselves to purely domestic markets. Increasingly efficient communication technology and the dismantling of regulatory constraints have encouraged globalization and as a result of that international financial markets experienced increased efficiency over time.

On the contrary, the criticism of international diversification includes the fact that international securities are by nature riskier than domestic ones: they provide either a higher compensation or lower risk (Lim et al, 1998). Many authors (Gulko, 2002; Ilmanen, 2003; Connolly et al, 2005; Baele et al, 2009) also agree that the extent to which gains of international diversification offset higher risks has implications for the efficiency of the market. As a result of that, if markets are efficient, investors can't earn excess returns by internationally diversifying. Contrarily, B. Solnik (2000) argues that in a fully efficient, integrated, international capital market, buying the world market portfolio would be the natural strategy. According to the author, various capital markets in the world should have independent price behavior and mere size of foreign markets justifies international diversification. So, as a result of this international investment should lower the risk without sacrificing the expected return.

With globalization and free flow of capital, developed markets became highly integrated into the world market and correlations across different countries have increased (Brennan, Kobor and

Rustaman, 2011). According to M. I. Gallali and B. Kilani (2010) these correlations play a determinant role in an international diversification strategy. For this reason, an accurate evaluation of this factor helps investors to form an optimal portfolio. Due to increased significance of international perspective in financial markets, knowledge of international financial market structure becomes very important. Despite of the stronger comovements between the markets offsetting the gains of international diversification, only rare investors limit their choices with domestic financial assets. This may even not be possible. Investors from smaller countries usually do not have a choice and in order to reduce the risk they are almost obliged to diversify outside their native economy. It has also became very hard to diversify inside a big economy due to exaggerated relationship between all the participants inside the market and the increased correlations between them. In this context international portfolio diversification becomes dominant portfolio allocation strategy for most of the investors not taking into account their initial markets.

With the increased dependence between XXI century's financial markets, accelerating globalization and the integration of single currency in EU the relevance of the question of international diversification is increasing at the speed of light. D. M. Rey (2000) states that worldwide comovements structure of financial markets influences capital flows, investment and consumption decisions and at the same time investors are interested in relationships of comovements for diversification motives. As it was already mentioned, international portfolio diversification is usually seen as the best way to improve portfolio performance. Despite of that, the extent to which international investors may be able to reduce the risk highly depends not only on stability of market returns but also on relationships between different markets (usually expressed in correlation coefficients). High levels of comovements between markets of specific asset classes and market indices moving together make diversification strategy hard to implement. In order to better understand comovements between stock and bond markets, it is necessary to firstly investigate the markets and comovements inside these markets.

1.2. Modern Financial Markets. Overlook of Stock and Bond Markets

1.2.1. Stock Markets and Comovements between Them

If there exists a sacred belief among investors, it is that equities are the best asset for the long run. A strategy of buying a diversified portfolio, being patient and waiting for reward is a commonly used one. This might be seen as more beneficial when comparing to holding cash or government bonds which may offer safety in the short term but leaves investor at risk from inflation over longer periods. Z. Bodie et al (2010) define that equity securities, or just equities, have two most important characteristics: its residual claim and limited liability features.

Investments in stocks are traditionally seen as a choice of less risk averse investors, usually aiming for a long-term gain. The return on investment has to compensate for not using the money and provide a risk premium for investing in risky asset, so if everything goes well in the end investor should have gained a high return during a long run. Appendix 2 reflects a global view for century-long history (1900-2000) of international stock markets providing average nominal and real returns in 16 developed countries. The real returns on stocks are much smaller than the nominal ones, highlighting the importance of inflation and the fact that it "eats" the lion part of the investment. This also reflects the returns on investments in bonds. Appendix 3 represents equity risk premium over government bonds in two periods: 1900-1999 and 2000-2011. During the last years the return on equities has been much lower than on government bonds. This might be explained by two reasons. Firstly, financial crisis and increased governments' demand for borrowing raised the risk-free interest rates. Secondly, financial crisis had a big influence on decrease of profitability of companies. As a result of that, it is not surprising that investors' attention has moved from stock markets to bond markets as being both safer and providing historically higher returns.

The overall performance of stock market in a particular country is reflected by stock market index. Index values are useful for investors to track changes in market values over long periods of time. For example, the widely used Standard and Poor's 500 Index is computed by combining 500 large capitalization US stocks together into one index value. Investors can track changes in the index value over time and use it as a benchmark to compare their own portfolio returns. There is a variety of stock market indices some of which are broad-based and others that are specific to one industry or type of investment (such as international investing). They can be classified according to different traits, but usually when talking about different countries it is referred to the benchmark index. Most widely quoted stock market benchmark indices come from the US as the strongest financial market: Dow Jones and Standard & Poors. Despite of that, development of financial markets worldwide includes the construction of indices for other markets. Among these are Nikkei (Japan), FTSE (the UK), DAX (Germany), Hange Seng (Hong Kong). A leader in the construction of international indices has been MSCI (Morgan Stanley Capital International), which computes over 50 country indices and several regional ones. The investigation of these and other major indices helps to determine comovements between stock markets in different countries. These comovements have been widely studied by various authors. Some of the results obtained can be seen in Table 1.

A. Rua and L. C. Lunes (2008) calls the analysis of the comovements of stock market returns the key issue in finance because of having important practical implications in asset allocation and risk management. They also state that it's extremely important to distinct a short-term and a long-term investor, supporting by the fact that short-term investor is naturally more interested in comovements of stock returns at higher frequencies (short-term fluctuations). A noteworthy finding of A. Rua and

L. C. Lunes (2008) is that the strength of the comovements of international stock returns depends on the frequency: in general comovements between markets is stronger at the lower frequencies suggesting that the benefits from international diversification may be less important in the long-term than in the short-term. It was also found that the degree of comovements changed over time.

Table 1

Summary of previous researches of comovements between stock markets

Author	Period	Countries	Data	Findings
B. Solnik (2000)	1971-1998	G7		Correlation not significant enough, possible to spread the risk
D. M. Rey (2000)	1973-1999	G7 and Switzerland	Main stock market indices	Correlations between stock markets are unstable over time
H. S. Lee (2001)	1998-2001	The US, Japan, Germany, Turkey and Egypt	Daily composite stock market indices	Confirmed spillover effects from developed to emerging markets
K. Phylaktis and F. Ravazollo (2004)	1980-1998	Japan, the US, Hong Kong, South Korea, Malaysia, Singapore, Taiwan and Thailand	Stock market index prices from Datastream	Increased comovements in stock markets without particular increase in comovements during financial crisis
F. Rezayat and B. F. Yavas (2005)	1999-2002	The US, Japan, Germany, France and the UK	-	Comovements among the markets were significant and varied over time.
A. Rua and L.C. Lunes (2008)	1973-2007	The US, Japan, Germany, the UK and Canada	-	Benefits from international diversification is stocks markets are more important in short term
M. I. Gallali and B. Kilani (2010)	2000-2008	G7	Weekly data of main stock market indices	Significant effect of correlations and volatilities between the US and other stock markets
I. Moldovan and C. Medrega (2011)	2004-2007 and 2007-2011	The US, the UK and Japan	Dow Jones Industrial Average, FTSE and Nikkei stock market indices	Correlation of stock market indices increase in times of financial crisis
H. Y. Lee (2012)	2006-2007 and 2007-2008	Various big economies	Daily returns of international stock market indices	Increased correlation between the markets in times of financial crisis
R. Horvath and D. Petrovski (2012)	2006-2011	the Czech Republic, Hungary, Poland, Croatia, Macedonia and Serbia	Stock market indices of the countries investigated and STOXX Europe 600	Stock markets of Central Europe are much more integrated with developed markets than markets of South-Eastern Europe

Source: compiled by the author

D. M. Rey (2000) found that average correlation together with systematic risks in stock markets increased almost 40 percent from early seventies. In addition, these correlations are positively related to volatility of the markets. The continuously changing relationship between international stock markets makes it hard to select ex-ante optimal investment strategy. Even though investors would be willing to gain from international diversification when markets experience high volatility periods, this is hardly done. Similar results were obtained by F. Rezayat and B. F. Yavas (2005) in their study confirming significant comovements between studied stock markets, especially when talking about European stock markets. Despite of that, authors claim that international portfolio diversification can still be used if investor would divide his investments between European and Japanese markets which

tend to have smaller correlation in between. Controversially, according to the study, implemented by B. Solnik (2000) in 1971-1998, the correlation coefficients between stock indices of world's biggest markets were rarely bigger than 0.5 and left opportunities for international investors to spread risk. The degree of independence of stock market is directly linked to the independence of nation's economy and government policies.

H. Y. Lee (2001) examines price and volatility spillover effects across international matured and emerging stock markets and obtains results, confirming price and volatility spillover effects from the developed stock markets (the US, Japan, Germany) to Turkey and Egypt. Emerging markets were found to be more connected with major economies than it was assumed to be. Similar results were later obtained by R. Horvath and D. Petrovski (2012). The authors compared the comovements in stock markets in Central (the Czech Republic, Hungary and Poland) and South Eastern Europe (Croatia, Macedonia and Serbia) and found price and volatility spillover effects from developed Western markets to this region. The authors also suggest that the connections are much more significant in Central Europe. On the contrary, the correlation coefficients obtained comparing South Eastern European stock markets with developed markets were close to zero. Another tendency noticed is that all stock markets have experienced losses at the beginning of the financial crisis in 2008 but this crisis didn't change the degree of stock market integration in these countries.

The research of I. Moldovan and C. Medrega (2011) has shown that comovements between stock market indices in major economies tend to increase with the worsening of financial situation (in time of financial crisis). The authors explain this by panic in investors' behavior which, according to them, is more intense than enthusiasm expressed during growth periods. Similarly H. Y. Lee (2012) studied whether the sub-prime mortgage financial crisis of 2007 influenced the stability of the correlation structure in international stock markets. The results show that there existed high correlation coefficients during sub-prime crisis and the investors gained from diversification by holding less investment portfolio consisting of diverse stocks from these suffering contagion countries. These results contradict with K. Phylaktis and F. Ravazollo (2004) who found evidence that the Asian crisis did not have a substantial effect on the degree of linkages of between the markets investigated. They also claim that relaxation of foreign exchange restrictions is not sufficient for increase of integration between markets. Although comovements between international stock markets increased in recent years, according to the authors they are mostly affected by national factors. This leaves a chance for international diversification and long-term gains by investing in these markets.

M. I. Gallani and B. Kilani (2010) applied GARCH model for G7 countries and observed the existence of reverse relationship between correlations and individual volatility of equity markets. When the volatility diminishes, correlations between markets increase for almost all countries and indicate a significant impact of individual volatilities and correlations between the US market and the

other markets. The authors also noticed that during the last decades, financial markets have experienced an increased integration. Due to this tendency, correlations between markets increased and benefits from international diversification decreased.

As it could have been expected, the majority of analyses of comovements between stock markets were implemented in world's biggest economies with few exceptional studies analyzing specific regions (South-East Asia, Central and South-East Europe). The lack of analyses in smaller emerging markets makes the trends less adaptable for common conclusions. In addition, the research periods are either very short (because of usage of daily data), or longer, but not up-to-date, making comparison harder. Even the studies in major markets are implemented with different methodologies and though are hardly comparable. The mostly used parameter for comparison – correlation between stock market indices – helps to evaluate and compare the researches. There is a tendency that correlations between stock indices increased with markets going more global. In addition, in times of worsening financial situation most of the studies also found the strengthening of correlation. Despite of that, the pure fact that some of the authors obtained opposite results (Solnik, 2000; Phylaktis and Ravazollo, 2004) makes this statement even more questionable and requiring for further investigation. There is a necessity to examine either this tendency is also valid in bond market studies, given into account that these markets are much less investigated.

1.2.2. Bond Markets and Comovements between Them

The market capitalization of international bond markets is much larger than the capitalization of international equity markets. Despite of that, comovements in international bond markets are much less investigated comparing to the large body of literature on international equity markets (Abad, Chuliá and Gómez-Puig, 2009). E. S. Lim et al. (1998), C. Ciner (2007) and other authors also agree that while there are numerous studies analyzing relationships between international financial markets most of them concentrate on equity markets and only very few empirical works examine the linkages of international bond markets. The empirical findings are inconclusive and represent a number of different perspectives. C. Ciner (2007) highlights two main reasons to investigate the bond market:

- Bond markets represent a huge segment of international asset markets and the understanding of comovements between them is important to design effective portfolio diversification strategies. With the strong relationship between international bond markets, the benefits of diversification can be lost in a long run.
- Government bonds can be the indicators of monetary policy actions: if shocks are transmitted to markets, the conduct of monetary policy will be sensitive to international developments not less than to domestic concerns.

Usually referred to as being much less volatile than stocks, bonds as financial instruments are becoming more and more popular. There used to be a significant distinction between corporate and government bonds. The latter ones, backed by the full faith and credit of the governments, lead market participants to view them as having no credit risk (Fabozzi, 2000). Barassi et al. (2001) states that bond yields or long-term interest rates can be seen as analogous to other asset prices or as monetary policy instruments. J. Yang (2005) adds that in deregulated international financial markets bond yields are expected to move together, primarily depending on the seriousness of the remaining barriers for entering the market. Here it is worth mentioning the difference between the US and the rest of the world. Despite of having a strong Treasury bond market (investment rate bonds, rated BBB or higher), the US has also established a high-yield corporate bond ratings varying up to even C. That is not the case for Europe and other markets. Only few non-US countries have a corporate bond market. That means that global bond market is completely dominated by government bonds. The bonds issued by the government will most probably have a higher price than the ones issued by the company because it will be considered that there is a bigger possibility of default for a company than for a state. Additionally, the main government bond markets are very liquid because of high demand for bonds in issue and the relatively small number of stocks in issue.

As in stock markets, a wide range of bond market indices available can be classified as broad-market indices and specialized market indices. Differently from stock market indices, investors usually know little about bond market indices – this concept is relatively new and not widely published. According to F. K. Reilly and K. C. Brown (2010) the knowledge regarding these indices is becoming more important due to the growth of fixed income mutual funds and the consequent need to have reliable set of benchmark to use for evaluation of their performance. There is a big variety of bond market indices that can be classified by different criteria (Figure 1).

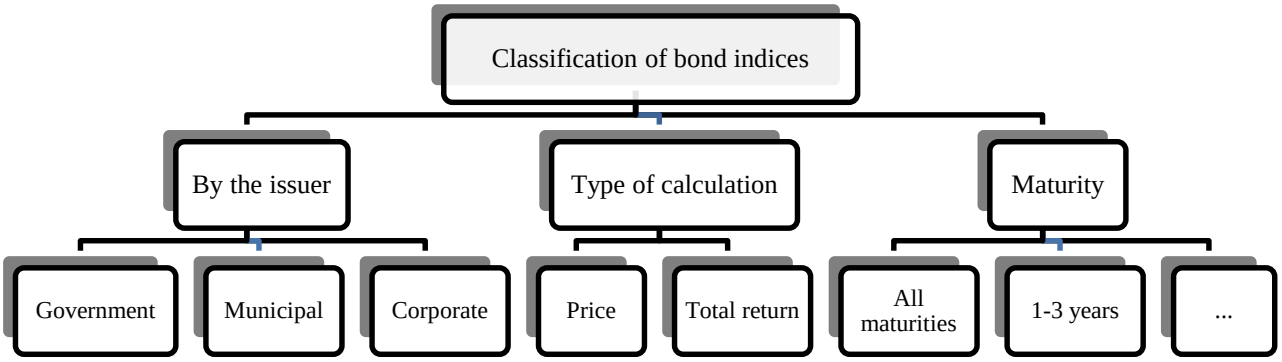

Figure 1. Classification of bond indices according to issuer, type and maturity

Source: compiled by the author

Classification by the issuer leads to distinction of government, municipal and corporate indices while classification according to the type of calculation divides bond indices into price indices and total return indices. A total return index measures the performance of a several components by assuming that all cash distributions are reinvested, but still tracking the components' price movements. It is different from a price index. This index only considers price movements (capital gains or losses) of the securities that make up the index, while a total return index includes dividends, interest, rights offerings and other distributions realized over a given period of time.

Despite of the fact that looking at an index's total return may be considered a more accurate measure of performance, the biggest benchmark indices in the world are daily quoted as price indices. There is no common agreement on the type of index to be used in the analysis. Different authors have used either total return indices (Lim et al, 1998; Baur et al, 2006; Baur et al, 2008; Viitanen, 2011) or price indices (Li, 2002; Bessembinder et al, 2008) in their bond market researches. Bond market indices reflect the performance of various categories of bonds. Three most well-known groups of indices are Merrill Lynch, Barclays (formerly Lehman Brothers), and Salomon Smith Barney (now part of Citigroup).

Several authors exclude the drawbacks of bond index calculation (Bodie et al, 2010; Reilly and Brown, 2010). As the major problem with these indices it is stated that true rates of return on many bonds are difficult to compute because of infrequent trading which makes it hard to get reliable, up-to-date prices. Other difficulties in calculation appear because:

1) the variety of bonds is much bigger than variety of stocks;

2) bond market is constantly changing due to new issues, bond maturities, calls, and bond sinking funds;

3) the volatility of prices changes because it is affected by the duration, which depends on changes in maturity, coupon, and market yield.

A. Clare and I. Lekkos (2000) state that the long-term bond rate is determined by expectations about future short-term real interest rates and inflation. As a result of that, monetary policy actions affect the term structure of interest rates. If the covariation between government bond rates in different countries increases, the ability of authorities to influence the term structure may decline. Investor in government bonds can be motivated to invest in different countries for several reasons. According to M. Brennan, A. Kobor and V. Rustaman (2011) the first and most classic reason would be to achieve volatility reduction of the portfolio. If there exist lags in economic and business cycles of different countries, it might be assumed that this would lead to less-than-perfect correlations between bond market indices. Beyond volatility reduction, investing in multiple countries could also be driven by return enhancement: the investor may find an attractive credit spread from a country with lower credit quality within the same currency zone, or the investor may expect positive carry from relative yield

curve differences across different currencies. Correlation between bond markets may appear through different channels, such as: holding internationally diversified portfolios; if real rates are determined by global factors; or if there is a 'flight to quality' in times of financial stress (Clare and Lekkos, 2000). The investigation of bond market indices started with F. K. Reilly, G. W. Kao and D. J. Wright in 1992 and became a more popular topic later on. Table 2 provides the main insights of researches by different authors in bond markets.

Table 2

Summary of previous researches of comovements between bond markets

Author	Period	Countries	Data	Findings
F. K. Reilly, G. W. Kao and D. J. Wright (1992)	1976-1990	The US	Corporate and government bond indices	Government bond indices were the least profitable in long-run
A. Clare and I. Lekkos (2000)	1990-1999	The US, the the UK and Germany	VARs using weekly one-year and ten-year the US, the UK and German interest rates	At times of global financial turmoil the slopes of yield curves react mainly to international factors
D. Balios and M. Xanthakis (2003)	1995-2001	The UK, Germany, France, Italy, Spain, the US and Japan	Daily data of main countries' stock market indices	The US stock market is the most important in the world and Europe is dominated by the UK market
J. Yang (2005)	1986-2000	The US, Japan, Germany, the UK, Canada	Bond Markets	No long-run relationship
C. Ciner (2007)	1988-2005	The US, Japan, Germany, the UK	JP Morgan Government Bond Indices.	Significant direct and indirect lead-lag relations between the markets.
P. Abad, H. Chuliá and M. Gómez-Puig (2009)	1999-2008	All EU-15 countries except Luxembourg and Greece)	10-year Government benchmark yields from Datastream and Global Financial Data.	Integration of EMU government bond markets is incomplete. EMU and the US markets are also not highly integrated.
S. Black, A. Brassil and M. Hack (2010)	2007-2010	Australia	Non-government bond indices	Australian bond market was flexible in the years of financial crisis
M. Brennan, A. Kobor and V. Rustaman (2011)	1999-2010	G7	The Bank of America/Merrill Lynch government indices, MSCI government bond indices	Strong connections between different bond markets
B. Becker and V. Ivashina (2013)	2004:Q1-2010:Q3	The US	Investment portfolios of insurance companies	Bond portfolios also represent variety of risks

Source: compiled by the author

F. K. Reilly, G. W. Kao and D. J. Wright (1992) analyzed 15 different bond indices in the US market for the year 1976-1990 and were one of the firsts to discover that government bond indices had the lowest average returns when compared to all the other indices. They also noticed that the correlation of annual returns of indices varied from 90% to 99%. Despite of that, such a strong relation between bond indices was observed only in long term.

The results of other studies of comovements between bond markets are controversial. J. Yang (2005) founds no long-run relationship among the five major bond markets and claims that

international bond markets are only partially segmented in short run with no leadership role between the countries investigated. The author also states that an independent monetary policy with respect to long-term interest rates is possible in the long run and in short run effectiveness of a country's monetary policy is substantially affected by policies of other countries. The diversification of long-term investors between major bond markets only leads to a little decrease in risk. For short-term investments with active bond portfolio management strategies author suggests diversifying between the markets with little dynamic interaction with their country market. On the contrary to that, C. Ciner (2007) found evidence of co-integration between major bond markets and made a conclusion that benefits of international bond diversification may not be as significant as suggested in prior studies. Finally, there was evidence found that the US bond market is more influential in the information transmission process than other countries.

In their study D. Balios and M. Xanthakis (2003) found evidence that the US is the leading stock market in the world and Europe is dominated by the UK. Surprisingly, Germany's stock market, according to the authors, does not have a strong effect on other markets. Even though it developed very fast from mid-90, it still has not reached the magnitude of transactions of the London Stock Exchange. A. Clare and I. Lekkos (2000) also investigated the yield curves of the US, the UK and Germany long term bonds but did this from a different perspective. The authors found that these indices reacted to the main crises' in the end of 20^{th} century. The authors also found that risk premium and/or contagion effects have played an important role during the periods of financial turmoil, especially influencing the covariance between international bond markets.

P. Abad, H. Chuliá and M. Gómez-Puig (2009) implemented a comparative analysis for studying the effect of introduction of euro for the European government bond market integration. The authors concluded that the impact of the introduction of euro was important for the degree of integration of European government bond markets. Despite of that, euro markets are only partially integrated, since they are still segmented and present differences in market liquidity and default risk. The same tendency was noticed when comparing European Monetary Union (EMU) markets with the US, but surprisingly EMU countries are only partially integrated with the German bond market. Because of this reason the authors suggest that benefits from portfolio diversification are still possible within EMU.

M. Brennan, A. Kobor and V. Rustaman (2011) obtained results showing that global government bond markets became largely integrated with time but local factors still have significant impact on returns of bond indices: they can explain around 20-25% of total risk premium. These correlations between the G7 markets suggest some diversification power but clearly represent a strong cross-border connection. The authors also emphasize sovereign credit risk in Eurozone government bond markets and investigate a probability of sovereign default. One of the most significant

observations made by the authors was that the lower the credit rating is, the more valuable diversification becomes in mitigating potential losses due to financial distress. In the context of increased independence between bond markets, the results of s study by S. Black, A. Brassil and M. Hack (2010) indicate that Australian bond market is highly independent from other global bond markets. It managed to avoid contagion of downgrading or even defaults. The overall issuance during the times of financial turmoil slowed down but this resulted in increase of quality of new bonds issued, tighter bond covenants and wider spreads.

Finally, B. Becker and V. Ivashina (2013) investigated the phenomenon of *reaching-for-yield* in corporate bond markets and found that insurance portfolios are systematically biased towards higher yield. Reaching-for-yield is most obvious during the time of economic expansions, so it is positively related to business cycle. A comparison of the ex-post performance of bonds acquired by insurance companies represents high systematic risk and volatility.

The synthesis of previous researches in bond markets leads to several important notes. As it can be clearly seen, the majority of researches have been implemented in the US as having the most developed bond market. Several researches include bond markets of European countries, but the countries investigated are usually the most developed economies or the countries belonging to the Eurozone. Studies designated for bond markets of new EU member states, not belonging to EMU, are very rare, so it is hard to estimate the integration of global bond markets. There is also not much consistency in bond indices used. In addition, due to financial stress in financial markets and increased attention for investments in government bonds, recently providing historically high returns, there exists an urge for a deeper investigation in government bond markets in all the countries of EU and especially for their comovements with stock markets. In order to investigate this relationship, analysis and synthesis of previous studies in this area is provided in the following section.

1.3. Comovements between Stock and Bond Markets

1.3.1. Nature of Comovements between Stock and Bond Markets and Flight-to-Quality

For a long time there has been a tendency of analyzing the pricing of fixed-income securities and equities on separate dimensions. Both of these areas generated novelties and there hasn‘t been a need for merger. According to D. G. Baur (2009), the increased accessibility of global stock and bond markets, reduction in trading costs and the integration of financial markets has led to a higher degree of international stock and bond market comovements. It might be explained by globalization, associated interdependence of markets and increased similarity of investor behavior. Recently some of the authors started questioning the separation between financial markets of different asset classes and offering models for explanation of the connections between them (Bekaert and Grenadir, 2001; Kim et al, 2006; Jang et al, 2008). A topic that conveys both areas of research is the analysis of cross-

market correlations which is named to be the core of many financial decisions, including risk management and optimal allocation of financial assets (d'Addona and Kind, 2006). The risk of portfolio depends not only on the risk of the securities of which it is composed, but also on the links between the various securities, through the effect of diversification (Esch et al, 2005; d'Addona and Kind, 2006). Maslov and Roehner (2003) emphasize the lack of completely deterministic relationship between stock and bond markets: it is virtually impossible to control for all the variables that influence the relation. For example, the authors claim that stock market is only slightly dependent upon interest rates and bond market has very strong connection with them.

Most of the authors analyzing relationship between financial markets agree that international diversification in the same asset class helps to reduce the risk and to earn bigger returns. Despite of that, separate researches in two main asset class markets revealed a changed tendency. It's not possible to continue diversifying investments into equity and bond markets as being completely different firstly because of risk-return relation. In recent years it became obvious that stock and bond markets are converging: government bonds are providing bigger returns, and they can no longer be referred to as 100% safe investments. This leaves investor wondering whether diversification between these two asset classes is more beneficial than international/regional diversification in the same asset class. Given that stocks, long-term government bonds and other high grade long-term fixed income products account for a dominant share in all traded financial assets, one might think that economists would have already answered this fundamental question. However, despite its ultimate importance, the nature of this correlation remains elusive (Li, 2002). N. Aslanidis and C. Christiansen (2010) notice that most studies have focused on realized volatility in stock and bond markets, and much less analyze the realized correlations of returns between assets. Figure 2 represents the standard deviations of stock and bond returns for the same countries averaged for 100 years.

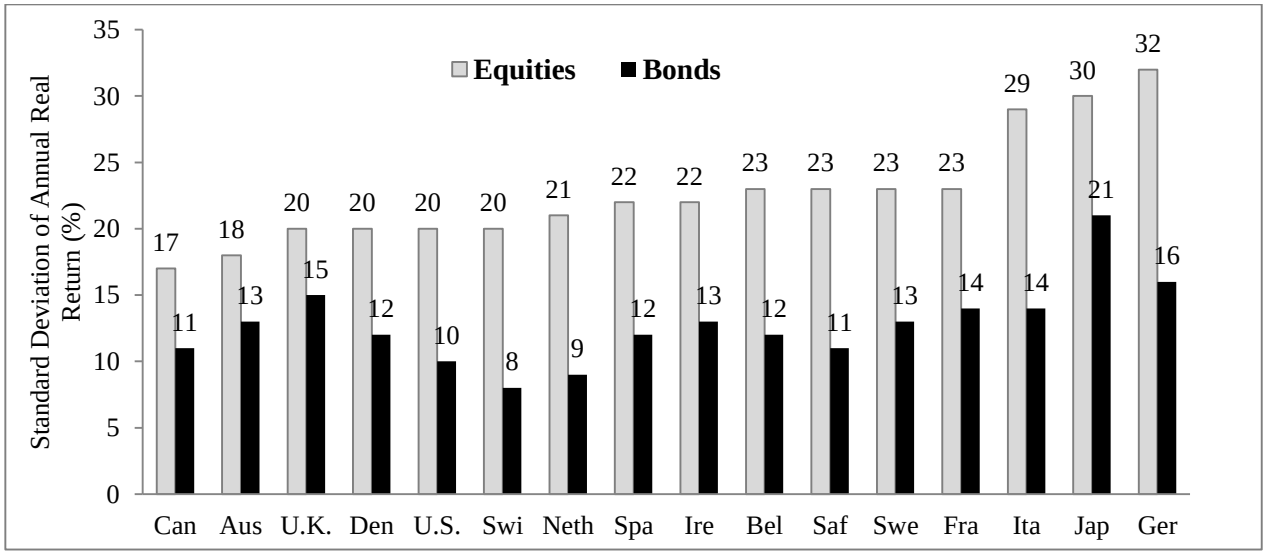

Figure 2. Standard deviations of real equity and bond returns in the world in 1900-2000

Source: compiled by the author according to E. Dimson, P. Marsh and M. Staunton (2002)

The lowest standard deviations on stock returns were observed in Canada and Australia, and the lowest standard deviation on bond returns – in Switzerland and Netherlands. An interesting feature of the figure is that the countries with the worst results, measured by the ratio of average real returns to standard deviation, are Italy, Belgium, Germany and Japan – countries, most devastated by World War II. On the contrary, the top-performing countries are Australia, Canada and the US, the countries, least devastated by the war of 20th century.

It is widely recognized that the correlation between stock and bond returns changes over time. Understanding the nature of the time variation in the stock-bond relation has very important implications for asset allocation and risk management, as they are the two most important asset classes (Connolly et al., 2005; Kim et al., 2006; Yang et al., 2008.). S. Maslov and B. M. Roehner (2003) claim that in general stock and bond prices don't display any significant correlation, but this can change on the specific time periods marked by crash. At those periods stock prices have a strong connection with interest rates on one hand, and with bond yield spreads on the other.

Comovements in asset market returns provide indirect evidence on financial markets' expectations and their reaction to common information that is priced into different asset types (Kim et al, 2006). Most recent theoretical models for stock-bond return relationship were formed on the basis of informational linkages. S. J. Kim et al. (2006) exclude two main channels through which information drives that relationship: 1) common sources of information influencing expectations in both stock and bond markets at the same time; and 2) sources of information that only alter expectations in one market but spill over into the other market. S. d'Addona and A. H. Kind (2006) notice that researches of the relationship between stocks and bonds are differently oriented. They usually differ with respect to the scope of the economic foundation and the focus on statistical fit. Three major lines of research may be identified: econometric papers (perspective is usually taken by adapting GARCH models), papers based on fundamental economic models, and papers that uncover empirical stylized facts of stock-bond correlations.

L. Gulko (2002) finds evidence in favor of decoupling of stock and bonds during stock market crisis. This is usually referred to as flight-to-quality. D. G. Baur and B. M. Lucey (2006) define flight-to-quality from stocks to bonds as an action of investors moving their capital away from riskier investments to the safest possible, usually caused by uncertainty in financial markets. Flight-from-quality from stocks to bonds, meanwhile, is the opposite phenomenon. This effect together with contagion (an increase of the correlation coefficient in a crisis period compared to benchmark period) are exclusive effects with regard to stock-bond correlations. If there is a contagion, there is no flight-to-quality and vice versa (Table 3). An increase of the correlation between stocks and bonds could be caused by jointly falling/rising markets.

Table 3

Overview of flight-to-quality, flight-from-quality and contagion

Market situation	Stock-Bond Correlations falling	Stock-Bond Correlations rising
Stock Markets Falling	Stock-to-Bond Flight-*to*-quality	(Negative) Contagion
Stock Markets Rising	Bond-to-Stock Flight-*from*-quality	(Positive) Contagion
Bond Markets Falling	Bond-to-Stock Flight-*from*-quality	(Negative) Contagion
Bond Markets Rising	Stock-to-Bond Flight-*to*-quality	(Positive) Contagion

Source: D. G. Baur and B. M. Lucey (2006)

D. G. Baur and B. M. Lucey (2006) imply that flight-to-and-from-quality have the potential to increase the stability and resiliency of the financial markets since they can reduce the losses that investors suffer in crises' periods. Similarly, R. Connolly et al. (2005) and R. Connolly et al. (2007) obtain supportive results for the flight-to-quality hypothesis by finding that stock market uncertainty causes the level of comovements between stock and bond markets to decrease and raise the diversification benefits. Therefore, positive correlation between stocks and bonds is expected to be caused by common macroeconomic country variables, driving returns on both asset classes together. Meanwhile, a negative correlation should be caused by expected inflation or flight-to-quality, but it is still not agreed in the literature whether one of these effects dominates the other. If the reduction of risk is not seen as effective in bear markets when economy is dealing with financial crisis, the gains from international diversification decrease when they're most relevant. This is often connected to contagion in financial markets. On the contrary, if there exist assets, whose prices increase in periods of financial crisis, this can compensate for the losses incurred.

It is most commonly stated that government bonds are the safest choice for investors preferring a flight-to-quality while dealing with uneasiness in financial markets. When investors start substituting their government bonds for riskier investments, the correlation between returns in bond and stock markets should become negative (Connolly et al., 2005). The authors also suggest stock market uncertainty as a key explanation for the stock-bond return relation. Despite of the studies implemented, the explanation for long-term comovements in stock-bond relation is still under discussion.

1.3.2. Previous Studies of Comovements between Stock and Bond Markets

Stronger comovements among the assets of a given portfolio implies lower gains, in terms of risk management, stemming from portfolio diversification (Solnik, 2000). The correlation of stocks and bonds was firstly analyzed by D. B. Keim and R. F. Stambaugh (1986) who found a low positive correlation between stocks and bonds. Afterwards, a number of studies in this field have increased and the concentration of analysis from international diversification in stock markets was transferred to international stock and bond markets (Andersson, Krylova and Vahamaa, 2004; Baele, Bekaert and Inghbrecht, 2009; Baur, 2009). During the next decade the researchers ascertained that stock and

bond returns exhibit a modest positive correlation and in general tend to move to the same direction. Despite of that, recent studies documented sustained periods of negative correlation. Overall, it is commonly agreed that the correlation between stock and bond returns exhibits considerable time-variation (Gulko, 2002; Li, 2002; Cappiello et al, 2003; Fleming et al., 2003; Connolly et al., 2005).

There is a big set of studies purposed for analyzing the economic forces influencing the changes in stock-bond correlations via time and the summary of them is provided in Table 4. Many studies have been implemented for the relationship between stock and bond markets, but the results obtained are ambiguous. Some of the most interesting results are obtained by A. Ilmanen (2003), who found that most of the systematic risk in the economy is in equities or assets positively correlated with them. Government bonds hedge against tough times during equity meltdowns or recessions as well as in various financial market and global security crises. This is consistent with a study of J. Yang et al. (2009) in the US and the UK. The authors concluded that bonds are a better hedge against stock market risk and offer more diversification benefits in the US than in the UK. The higher stock-bond correlations tend to follow higher short-term interest rates and higher inflation rates. L. Li (2002) also indicates that expected long-term inflation is very important for determination of future trends of stock-bond correlations. Bonds also tend to lead stocks around cyclical turning points, and the bond-stock lead-lag patterns do exist. The relationship between stocks and government bonds is nothing but stable: the correlation tends to be positive but occasionally dips below zero. On the contrary to that, J. T. Scruggs and B. Glabadanidis (2003) found the conditional correlation since the mid-1960. Bond market variance increases in response to bond market return shocks and is almost unaffected by stock market return shocks.

Similarly D. G. Baur and B. M. Lucey (2006) analyze flight-to-quality and contagion in stock and bond markets and found extreme changes with high fluctuations between returns on stocks and bonds varying significantly over the post-war period. Those conditional correlations were negative in the late-1950 and early-1960's, but have been positive later on.

The volatility in stock and bond markets could explain up to 30 percent of stock-bond correlations. Higher stock market volatility causes the correlations to decrease while higher bond market volatility increases them. This fact indicates the existence of two phenomenon: flight-to-quality and contagion. In the study implemented two years later D. G. Baur and B. M. Lucey (2008) also obtained proof of flight-to-quality as s common feature in a crisis. These results imply that there is an asset class for which prices increase in times of financial stress. The flights mentioned can enlarge the stability and resiliency of the financial system: diversification gives its effects when it's most needed.

Table 4

Summary of previous researches of connections between stock and bond markets

Author	Period	Countries	Data	Findings
L. Li (2002)	1958-2001	G7 (the US, the UK, France, Germany, Japan, Canada and Italy)	Value-weighted market indices and long-term benchmark government bond indices	Large variations in stock-bond correlation caused mainly by inflation expectations
A. Ilmanen (2003)	1926-2001	G5 countries	S&P 500 for stocks and 10 year government bond benchmark	Positive correlation with periods of negative one caused by recessions, equity weakness and high-volatility
J. T. Scruggs and B. Glabadanidis (2003)	1953-1997	The US	CRSP index for stocks and long-Term government bond total return index	Significant fluctuations in conditional correlations between stocks and bonds
M. Andersson, E. Krylova and S. Vahamaa (2004)	1991-2004	US and Germany	S&P100, DAX indices for stocks and benchmark 10-year government bond indices	Varying correlation between stock and bond returns, positively related to expected inflation.
D. G. Baur and.B. M. Lucey (2006)	1995-2005	The US, Belgium, Finland, France, Germany, Ireland, Italy and Spain	MSCI stock and bond indices	Confirms flight-to-quality and contagion effects.
S. d'Addonna and A. H. Kind (2006)	1980-2000	G7	Datastream Market Indices for stocks and the JP Morgan indices for bonds	Inflation shocks reduce correlation between stocks and bonds
L. Cappiello, R. F. Engle and K. Sheppard (2006)	1987-2002	European countries, Australasia and the Americas	Benchmark stock indices and clean price government bond indices	The correlations of the assets have considerable variation.
S. J. Kim, F. Moshirian and E. Wu (2006)	1994-2003	France, Germany, Italy, Spain, the UK, Japan and the US	Benchmark stock and Government bond indices	Economic integration with reduction in currency risk improved financial integration but created uncertain sentiments on future of EMU.
D. G. Baur and B. M. Lucey (2008)	1994-2006	The US, the UK, Germany, France, Italy, Australia, Canada, Japan	MSCI stock and bond >10 year total return indices	Proved flight-to-quality and cross-country contagion
J. Yang, Y. Zhou, and Z. Wang (2009)	1855-2001	The UK and the US	Composite indices for stocks and 10 year government bond total return indices	Bonds help to hedge against stock market risk. US investors have better diversification opportunities
L. Baele, G. Bekaert and K. Inghbrecht (2009)	1968-2007	The US	Stock excess returns and bond excess returns, quarterly data	Correlations between stock and bond indices decreased via time.
D. G. Baur (2009)	1989-2009	Australia, France, Germany, Italy, Japan, Switzerland, the UK, the US	Various	Higher degree of linkages between markets and globalization caused increase in correlations
T. Viitanen (2011)	1999-2010	Australia, Belgium, Canada, France, Germany, Italy, Japan, the Netherlands, Spain, Sweden, Switzerland, the US	Local currency denominated stock and government bond market total return indices	Stock-bond relations under extreme market conditions are stable

Source: compiled by the author

Another approach is estimating the changes in correlations together with the changes in country's economic situation. S. d'Addona and A. H. Kind (2006) calculate historical correlations between stocks and bonds with exponentially weighted moving average correlation (EWMA). Their results indicate that inflation shocks tend to reduce the correlation between stocks and bonds and the higher variability of the dividend-yield boosts the variability of stock returns and reduces the correlation between stocks and bonds.

The novelty of approach can be found in work of M. Andersson et al. (2004). The authors examine how expectations for inflation and economic growth together with stock market uncertainty affect the correlation between stock and bond returns. The focus on expectations, instead of actual historical values, lets them to make a conclusion that stock and bond prices move in the same direction during periods of high inflation expectations, while negative stock-bond correlation coincides with low levels of inflation expectations. The results indicate that high stock market uncertainty leads to decoupling between stock and bond prices. The focus on expectations rather than real economic ratios was later continued by J. Yang et al. (2009). The authors found that bigger expectations for future inflation caused stronger comovements between stock and bond returns. This tendency is also valid for other macroeconomic factors, such as the real interest rate and unexpected inflation.

L. Cappiello et al (2006) find that both equities and bonds exhibit asymmetry in conditional correlation, although equities show a stronger response than bonds to joint bad news. The authors also document strong comovements in equity market volatility between different countries. Annualized average volatility series for equities show linkages during periods of financial stress, such as the stock market crash in 1987, the beginning of the Gulf War, and the Asian financial crisis. Bond market volatilities, differently, demonstrate less clear linkages, exhibiting, instead, increases to region-specific events. This is consistent with tendency, noticed by S. Maslov and B. M. Roehner (2003). The authors find a strong connection between stocks and bonds during crash-rebound episodes: immediately after the crash investors sell their risky bonds, and after the rebound they sell some of their safest bonds (usually government) to buy back some risky ones.

S. J. Kim et al (2006) continued a previous study of R. Connolly et al. (2005) who found that the future stock-bond correlation at higher daily frequency decreases with increasing stock market uncertainty in the US and several other major markets, concluding that this is influenced by the flight-to-quality phenomenon. The authors investigate stock and bond market integration over time and find that stock-stock and bond-bond market integration with EMU has increased. On the contrary, stock-bond market integration moved to zero and even negative mean levels in most countries, consistently with flight-to-quality phenomenon. It was also found that volatility between markets has stabilizing effects and the introduction of EMU caused an increased segmentation between stock and bond returns in European markets. The economic integration induced by the introduction of EMU and the

reduction in currency risk has stimulated inter-financial market integration. This has a drawback: increasing monetary policy convergence might have created uncertain investor sentiments in the international financial system.

L. Baele et al (2009) in their wide study observe positive correlations between excess returns of stock and bond indices until the end of 1980's, and decreasing correlations afterwards. They also exclude that non-macro variables, especially stock and bond market illiquidity factors, are the ones most likely to explain these correlations. These results coincide with D. G. Baur's (2009) who states that decline of stock-bond correlation in recent years is explainable by a more frequent portfolio rebalancing due to globalization and lower benefits from international diversification across similar markets. The results suggest that if investors act in a similar way across stock markets and across bond markets they also act in similar ways when they rebalance their portfolios and change the weights for stocks and bonds. Unfortunately, this fact does not explain the comovements of stock-bond relation. The findings of the author coincide with some previous researches stating that a higher degree of comovements between the markets and the globalization leads to increased correlations. According to this author the negative relationship between stock-bond comovements and stock-stock comovements in extreme stock market conditions implies that stock-bond diversification works when it is needed most in contrast to international diversification.

Finally, the newest study, implemented by T. Viitanen (2011) indicates that all biggest economies except Italy and Spain, exhibited financial market stability under extreme market conditions and potentially systemic events as assessed by their international stock-bond return relations. During extreme conditions in financial markets, correlations between stocks and bonds stay below or close to zero. The periods of extremely negative stock-bond correlations took place around the South American economic crisis in 2002, the financial crisis starting in 2007 and European sovereign debt crisis from April 2010. Overall, the negative relation between stocks and bonds implies that the bonds are excellent safe havens against major systematic risks.

The analysis and compilation of results obtained in previous studies of comovements between stock and bond markets has revealed several important drawbacks. Firstly, similarly as in separate studies of stock and bond markets, most of the studies of comovements between different asset classes have been implemented in the US or took into account only several European countries with no attention to smaller economies. Secondly, there was not enough unity in data and methods used by different authors. Thirdly, even though the previous authors found that relationships between stock and bond returns tend to decrease with the time, there is still a lack of investigation of how exactly this relationship changes in times of crisis. With the on-going financial crisis and decreased confidence in government bond markets, it is crucial to investigate the comovements between stock and bond markets in all the countries of EU.

1.4. Financial Markets in EU and Their Comovements in the Context of Financial Crisis

The foundation for the European Union (EU) was created in 1952 by Belgium, France, Germany, Italy, Luxembourg and Netherlands. Due to the growth of the Union, there were already 27 members in 2007 (Figure 3).

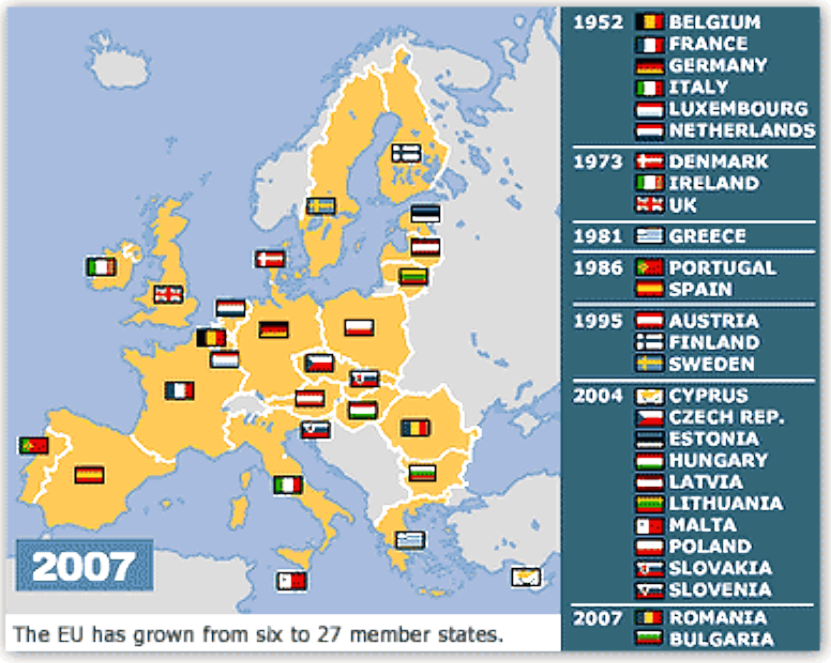

Figure 3. Development of the European Union

Source: http://news.bbc.co.uk

The extension of the EU in 2004 with 10 members was the widest acceptance of new members in the EU's history. The countries that joined EU in 2004 (Cyprus, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, Slovakia, and Slovenia) together with the last countries joining in 2007 (Romania and Bulgaria) are commonly referred to as the new members of EU. These countries are also thought to have less developed financial markets. Despite of common references to the US as the reflection of financial world, the markets in EU are of a big importance. One of the proofs for that can be seen in Appendix 4 which represents the pre-crisis data of 25 countries with largest equity capitalization in the World. These countries made up 85% of the World's gross domestic product in 2007. The overall growth of World's equity markets during those 5 years analyzed was more than 140%. Despite the fact that the US was an unquestionable leader of financial interactions in equities markets, its part in stock exchange transactions have significantly decreased (from 45.8% to 32.9% just in 6 years). The list includes 16 European countries from which 14 belong to EU. The total market capitalization of biggest EU countries was almost equal to the US, so the importance of EU stock exchanges is big worldwide. Consequently, there is an urge of investigating EU's financial markets.

Properly integrated financial markets in EU are vital to more efficient use and flow of investment capital, and thus to competitiveness of EU economy. Despite of commonly quoted stock exchange indices of major European countries and important, fairly liquid Eurobond market in EU, European stock markets very much move in the shadow of Wall Street. A big step towards escaping from this shadow and improving globalization process took place in 1999 when 11 European countries replaced their currencies with euro. The common currency had to facilitate trade and encourage integration of markets across national boundaries. Even though the biggest concentration of attention is usually on stock markets, integration of EU's bond markets is not less important. With the implementation of currency union and associated stabilization of macroeconomic fundamentals in EU, it's logical to ask whether there have been any influences on the integration process between stock and bond markets (Kim et al, 2006). R. A. De Santis and B. Gerard (2009) state that from the start of EMU investors invest a bigger part of their portfolio in EMU countries' equity and bond markets. So, the creation of EMU made the access to euro area financial markets substantially easier and helped the integration to develop. The one country suffering from this decision was the UK. Not adopting euro and being separated from EMU led to a trade diverting effect against the British bond market – euro area portfolio weight there decreased by about 3-4 percentage points.

According to, B. F. Yavas and F. Rezayat (2005) comovements between European markets changed significantly only in few cases after the introduction of euro. It may be caused by changes in variances within markets. While these results indicate that correlations do change following exogenous shocks, it is difficult to predict the direction of the change without a more detailed analysis. On the contrary, S. J. Kim et al. (2006) argue that the introduction of euro and associated monetary policy uncertainty has led to a segmentation of stock and bond markets evidenced by correlations with levels of mean zero. K. Bernoth, J. von Hagen and L. Schuknecht's (2006) analysis showed that the yield spreads highly responded to levels of government debt both before and after the start of monetary union. Despite of that, the empirical evidence suggests that credit markets further monitor fiscal performance of EMU countries and do not expect that countries in fiscal troubles will be fully bailed out by other countries in EMU or the ECB.

While it's obvious that investors' attention and the majority of studies are concentrated on EMU countries and the results obtained show strong comovements between these markets, there is a lack of studies in other EU markets. It is still not clear how stock and bond markets interact with each other in non-EMU states, especially the ones who joined EU during the last decade. A regional diversification within EU countries and within stocks and bonds inside them may be as much beneficial as global diversification, if it was proven that the biggest EMU financial markets have less dependence on the rest of EU's markets. One of the attempts to do that was implemented by N. Aslanidis and C. S. Savva (2009) who found that in most of EU's stock markets correlations increased

between 1997 and 2008. These correlations are stated to be driven by EU-related developments rather than worldwide financial integration. On the contrary, R. Horvath and D. Petrovski (2012) state that financial markets in Central and Eastern Europe are largely bank-based and due to this fact they are much less developed. This may be used for the benefit of investors. Firstly, it may be useful for international portfolio diversification. Secondly, although stock markets in these countries are relatively small in size, they still possess a predictive power for future economic activity and prices.

After introduction of EMU the convergence of government bond markets was supported also by zero risk weights assigned to government bonds in capital adequacy regulation and the ECB's practice of valuing all euro area countries' bonds on the same terms as collateral for central bank credit to banks (Kilponen et al, 2012). After this period there were few years when government bond yields remained stable and didn't highly react to economic situations in different countries. The situation changed in 2008 after the collapse of Lehman Brothers followed by financial contagion and systematic risk between the markets. This and other bankruptcies of huge financial institutions had a very harmful impact on European banks forcing governments provide support to their banking sectors and to use fiscal policy instruments to support their economies. At that time government bond yields started to reflect real country's economic situation firstly increasing in countries with a weak macroeconomic situation (Greece, Ireland and Portugal). On the contrary, economically stronger countries (Germany, the Netherlands) have experienced a decrease in long-term interest rates due to flight-to-quality. In this context comovements between stock and bond markets in EU became a highly questionable topic. The crisis has quickly spread to all the major markets of EU. The correlation of losses appeared in international financial markets as one of the effects of globalization. Extremely fast spread of financial problems from the American markets to the rest of the world from 2008 has only increased the belief that financial markets have tend to experience financial breakdowns simultaneously. According to M. Brennan, A. Kobor and V. Rustaman (2011) recent developments in the Eurozone government bond markets emphasize the concern about the impact of tail risk due to financial turmoil. Common monetary policy in Eurozone leads to shared exposure across different credit risk factors, and might potentially pick up yields from lower credit quality borrowers. Recently, downside risk has been a widely discussed topic for peripheral countries, driven by concerns about sovereign defaults, or the break-up of the Eurozone. Figure 4 represents the evolution of government bond yields for major euro area countries.

Due to intensification of sovereign debt crisis the euro area governments provided support for the banking sector. The financial markets reacted by widening of bond yield spreads in the euro area. Numerous important decisions were taken in order to save the banking system in EU and those decisions firstly affected the government finances: there appeared a possibility for states to default. This made investors to revise the concept of risk-free rate, usually assigned to government bonds.

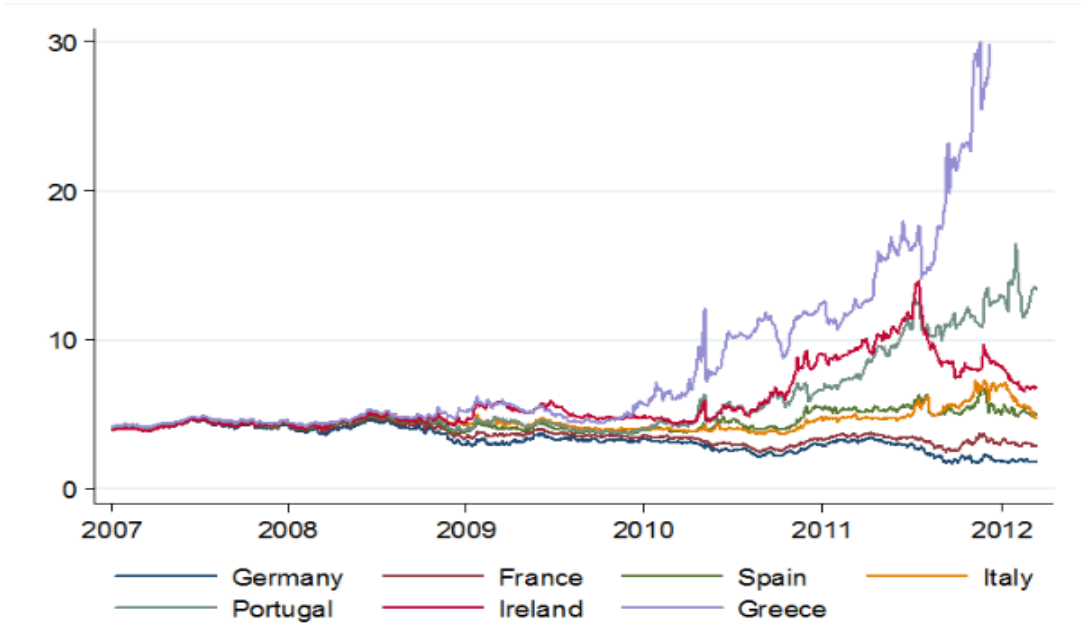

Figure 4. Yields of the 10-year government bonds for major euro area countries

Source: Kilponen, Laakkonen and Vilmunen (2012)

In some of the countries government bonds became very risky (Greece, Ireland, Spain, Portugal) reflecting the increased risk of country itself. As a result of that the risk premium for the government bonds far exceeded the equity risk premium of big companies leading to the record heights of both short and long term government bond yields. This fact was expected to change the relationship between stock and government bond markets in EU. T. Viitanen (2011) noticed that flights between stocks and bonds inside the country should occur in extreme market conditions and potentially systemic events, and the crises mentioned can be named as such. During his research in major European economies the author proved the existence of flight-to-quality phenomenon and highlighted its existence in Italy and Spain. Flight-to-quality was the least frequent in Germany, as usually considered to be Europe's strongest economy. Importantly, the author states that this exchange between stocks and bonds contributed negatively to the resiliency of stock-bond diversification benefits, thus weakening financial market stability.

The existence of comovements between major stock and bond markets in EU and flight-to-quality inside them proven by various authors seems to be reasonable. Despite of that, lack of studies implemented in other EU countries and the context of still ongoing crisis in EU makes it hard to verify the tendency in general. As a result, there is a necessity of analysis of comovements between all EU's financial markets. A lack of up-to-date analysis of comovements between markets of different asset classes in the same country also harms the strategies of diversification between stocks and bonds, as it might be not as beneficial and risk-minimizing as it is thought to be. A specific attention should be paid to the period of financial and sovereign debt crisis from 2008 as it is commonly argued to be

highly influential power to comovements between financial markets. Analysis implemented in the next two parts of this paper is expected to fill the gaps mentioned: to generalize the tendency of comovements between stock and bond markets in all EU countries and between the markets of different asset classes in the same country. This should be beneficial for both investors diversifying internationally and to the ones who diversify nationally. Specific attention paid for the period of financial and sovereign crisis in EU is expected to confirm or reject the hypothesis that comovements between stock and bond markets radically change in times of financial stress.

Summary of theoretical aspects of the issue investigated leads to the conclusion that majority of the researches of comovements between financial markets has been implemented in world's biggest markets, especially in the US or main Eurozone countries. This causes difficulties to adapt the results to EU economy as a whole. The bigger concentration of attention still exists on stock markets, with bond markets being less investigated. Furthermore, there exists variety of methods used for evaluation of comovements between stock and bond markets and the results obtained are not unified. One of the most common tendencies obtained by the authors is increasing correlations between financial markets mainly driven by globalization and financial stress in recent years. In addition, the volatility of comovements of stock and bond markets was also proven to be a common tendency. This volatility is mostly thought to be caused by inflation or recently increased gap between the costs of government borrowing (yield spread). A flight-to-quality was also proven in several studies, indicating that stock and bond market indices tend to move to different directions in times of financial stress. Interestingly, most of the authors did not exclude the countries with strongest comovements between financial markets, even if this would be beneficial information for internationally diversifying investors. Therefore, even though significant comovements between stock and bond markets were proven by majority of the authors, there still exists a lack of wider investigation of how strong these comovements are and how they change in times of financial crisis. These questions are investigated in the following two parts of the paper.

II. METHODOLOGY FOR THE INVESTIGATION OF COMOVEMENTS BETWEEN FINANCIAL MARKETS IN EU COUNTRIES

2.1. Characteristic of the Empirical Research Object: Stock and Government Bond Markets in EU countries

Free movement of capital is at the heart of the single market EU authorities are willing to implement. It enables integrated, open, competitive and efficient European financial markets and services bringing many advantages. For companies it principally means being able to invest in and own other European companies and take an active part in their management. Most of the exchanges in equities, bonds, derivatives and commodities in EU are represented by the Federation of European Securities Exchanges (FESE). FESE represents public Regulated Markets that provide both institutional and retail investors with transparent and neutral price-formation. Securities admitted to trading on these markets have to comply with stringent initial and ongoing disclosure requirements and accounting and auditing standards imposed by EU laws.

Even though the integration of EU's financial system is further increasing, the stock market of EU still consists of various different markets and they are not capable to compete with the US or major Asia's countries' stock exchange markets separately. According to the World Federation of Exchanges, at the year-end of 2012 only two equity markets of EU were in the list of 10 largest equity markets evaluated by capitalization in the world (Appendix 5). The ones to be mentioned are *Deutche Borse* and *London Stock Exchange.* The latter with around 3,000 companies from over 70 countries admitted to trading on its markets is the most international of all the world's stock exchanges.

The characteristics of EU's stock market can be reflected in various ways. One of the possible ways to compare the size of the equity markets in different countries is the comparison of the number of stocks listed in the market. This data for EU countries is represented in Table 5 (the codes of EU countries are presented in Appendix 6). It should be noted that these numbers include not only the official but also the additional list of traded stocks.

Table 5

Number of companies listed in the stock markets of EU countries in 2012

Country	ES	UK	FR	PL	DE	BG	SE	IT	EL	DK	BE	FI	CY	NL	RO	AT	SK	SI	HU	PO	IE	LT	LV	LX	MT	CZ	EE
Number of listed companies	3167	2179	862	844	665	387	332	279	267	174	154	119	111	105	77	70	69	61	51	46	42	33	31	29	20	17	16

Source: compiled by the author, based on *The World Bank* data.

It can be initially seen that the biggest equity markets in EU in terms of number of companies listed are Spain and the UK. The stock markets of these two countries represent a higher number of companies listed than the rest of the countries taken together (more than 5000 companies). Other

countries, having high number of listed companies in 2012 were France, Poland and Germany. On the contrary to the biggest stock markets in EU as the smallest ones should be excluded Estonia (16 companies), Czech Republic (17 companies) and Malta (20 companies). Most of the Central-Eastern European countries have a small number of listed companies in their stock exchange markets, with the exception of Bulgaria (387 companies). It is also interesting that Austria, Portugal and Ireland have a very small number of companies listed (correspondingly 70, 46 and 42). Scandinavian stock markets are average in this listing, with the biggest one being Sweden (332 companies) while Denmark's and Finland's stock exchange markets in terms of companies listed are similar to Belgium's. Italy and Greece have almost the same number of listed companies (correspondingly 279 and 267). Surprisingly, there is a big amount of companies listed in Cyprus's market having in mind the relatively small size of country's economy. This number even exceeds the number of companies listed in Netherlands' stock market (105).

Even though the number of companies listed helps to determine the relative positions between stock markets of EU countries, it does not reflect the amounts traded and the liquidity of these markets. Figure 5 provides a view towards stock markets in EU by highlighting the total value of stocks traded in each of the member state's stock markets in 2012.

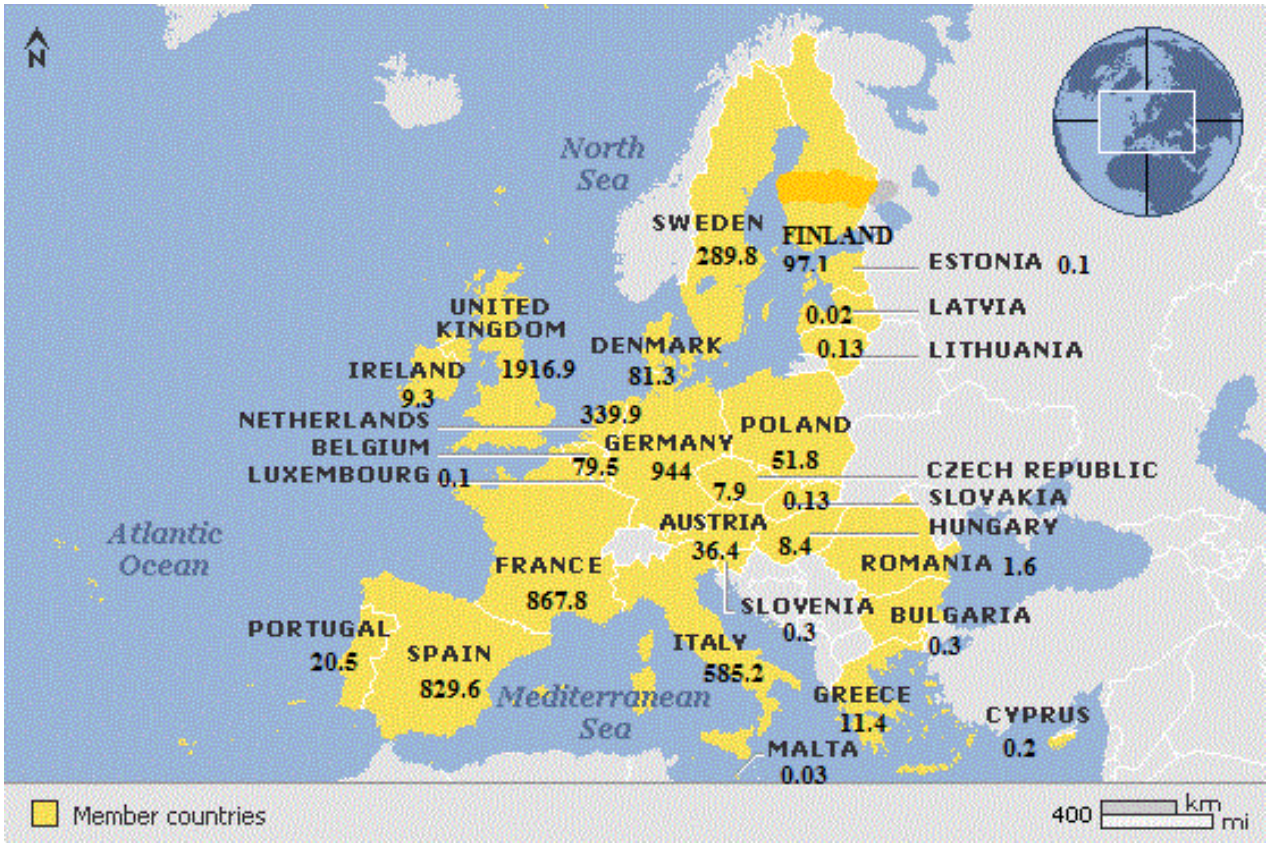

Figure 5. Total value of stocks traded in stock markets of EU countries in 2012 (billion €)
Source: compiled by the author, based on *The World Bank* data.

The values provided are in billions of euros. Even though in terms of companies listed Spain was the biggest equity market in EU, the total value of shares traded during the year 2012 was

recorded in the UK. This amount was more than 2 times bigger than in Spain being close to 2000 billion € and confirming London Stock exchange being the biggest stock exchange in Europe. The second in terms of traded stock value was Germany's stock market with 944 billion €. With the third being France (867.8 billion €), Spain is the fourth. Italy should also be mentioned as the country with very high total value of stocks traded, being more than 585 billion €. It is interesting to see that the earlier comparison of stock markets in terms of listed companies does not reflect strength of equity market positions in a specific country. As it was mentioned, there are more companies listed in Cyprus' stock market than on Netherlands' market. Despite of that, comparison of the total value of the stocks traded in 2012 shows opposite results. The total value traded in Cyprus was only 0.2 billion € while in Netherlands it almost reached 340 billion €. Again, it can be seen that stock markets of Eastern, Southern and Central Europe had very small value traded, mostly being smaller than 1 billion € per year with the exception of Poland (51.8). Nevertheless, having in the number of companies traded in Poland's stock exchange, this amount is relatively small. The amounts of stock value traded in Scandinavian countries weren't very high, but Sweden's market exceeded Finland's and Denmark's by about 3 times (correspondingly 289.8, 97.1 and 81.3). The amounts traded in Belgium's stock market were similar to Denmark's while Portugal's and Ireland's traded stock values were relatively small (correspondingly 20.5 and 9.3 billion €).

The government bond market of EU countries comprises from multiple domestic bond markets where governments, sub-sovereign entities and corporations in residence issue bonds, and individual investors participate. Despite of that, in the same way as stock markets, EU bond markets are increasingly acting like a single market. Government of every EU country issues bonds and individual investors are able to buy them in their country of residence, whether in Europe or abroad. Investors are also able to purchase government bonds issued in another country belonging to EU. The development of euro lead to possibility of buying government bonds in other Eurozone countries without additional currency risk. In addition, government bonds issued by separate countries need to be attracted international investors.

Due to the fact that it was not possible to receive the data of government bond market capitalization in EU countries, an insight towards the need for governments to borrow can be derived from the Figure 6. It provides data of the debt of EU governments as the government debt to GDP ratio in 2012. It can be seen that Greece's, Italy's, Portugal's, Ireland's and Belgium's governments have debts, higher than 100% of their gross domestic product. With the assumption of these debts not being stable and increasing in financial crisis, the necessity for governments to issue bonds in these countries is strong. On the contrary to that, Estonia, Bulgaria and Luxembourg tend to have lowest debt ratios.

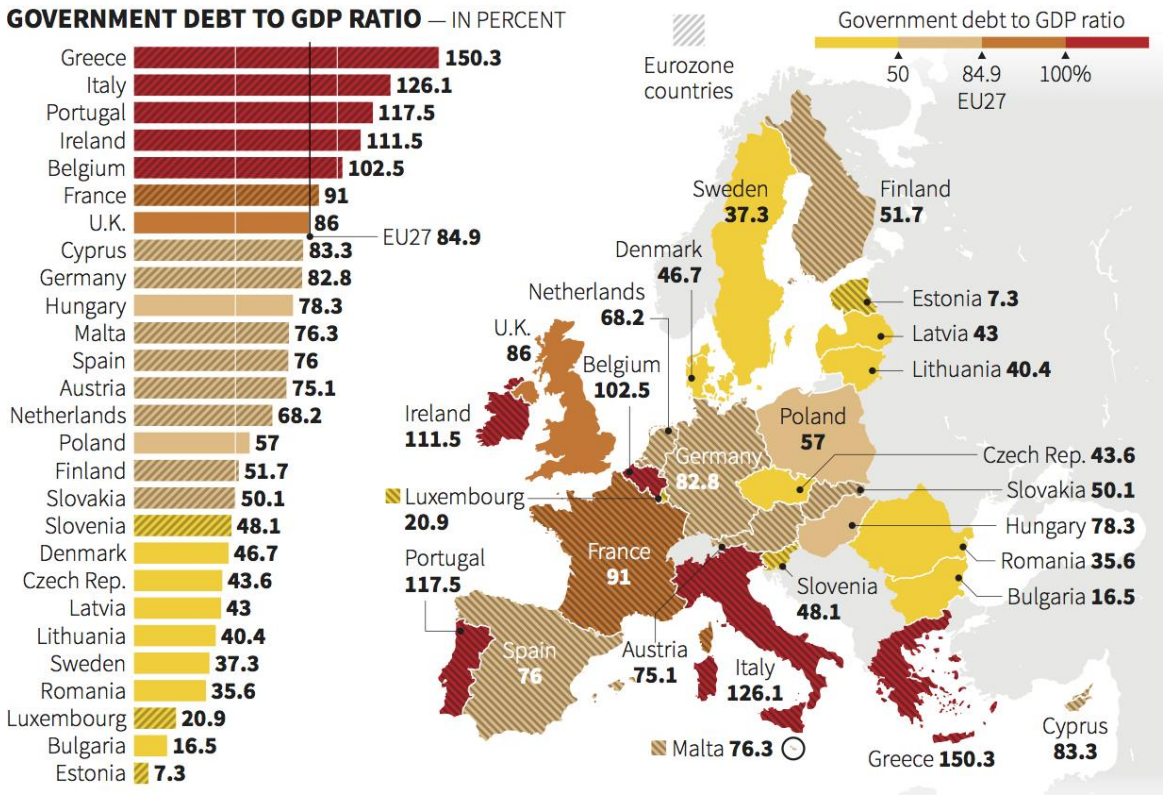

Figure 6. Government debt to GDP ratio of EU countries in 2012

Source: *Thomson Reuters* (based on *Eurostat* data)

Most of the new EU members tend to have smaller government debts. This might be influenced by higher risks of these sovereigns and as a result of that, high costs of debt that repel these government from borrowing. Mainly dominated by institutional investors, according to P. Dunne, M. Moore and R. Portes (2006), most of national government bond markets in Europe are relatively small in scale when comparing with US government bond market. Government bonds were demanded by private agents to provide benchmark returns across the yield curve. They also provided risk-free assets for optimal portfolio management. The benchmark return is determined by French and German government bonds at different points on the curve. Other national governments within EU used to attract much less investors as a result of that being a small liquidity in these markets.

The current situation of EU countries' government bond markets is highly affected by the intensification the sovereign bond market crisis. Yield spreads between different countries significantly increased together with much more difficult access to primary government bond markets, dominated by risk-averse investors preferring quality and liquidity rather than higher return on investment. The spread between government bond indices in separate countries has never been that big. As the prices of bonds issued by EU governments are reflecting the credit risk of the country, smaller EU members or the ones with high fiscal debt need to pay a huge premiums for the possibility to lend money. This actually divests risk-averse investors from risk-takers as the latter tend to invest to riskier government bonds with a provision of higher returns. The ongoing financial turmoil,

referred to as European sovereign debt crisis, moved the focus from EU equity to sovereign debt markets and exaggerated the demand for government bonds. As a result of that government bond markets of EU countries have become as liquid as never with the indices calculated reflecting constant changes in these markets.

2.2. The Relevance and the Aim of the Empirical Research

The fast integration of global financial markets is proven to leave less and less space for portfolio diversification as comovements of international markets are claimed to be driven by the same forces. This integration in EU countries was reinforced with the adoption of the common fiscal and monetary policy, and, later on, the introduction of the euro. Despite of that, investors in EU area still search for diversification possibilities between financial markets of different countries or between different asset classes in the same country. During this process it is a question of essential significance whether the financial markets of EU countries are strongly related and move together, or they can still be used to benefit from regional diversification or diversification between asset classes. Historically risk-averse investors tended to choose investments in government bonds, being less volatile, providing smaller return and being seen as safe haven in times of stress in financial markets. In the context of European sovereign debt crisis, increased risk of countries themselves and the ongoing debate of whether government bonds can still be seen as securities representing the minimum risk, stocks and government bonds are gradually becoming substitutes and do not separate investors into risk-averse and risk-takers. Furthermore, due to proven changes of relationships between financial markets in times of financial stress, the analysis of stock and government bond market comovements in the context of still ongoing financial crisis becomes of a high **relevance**. In addition, many investors in EU countries traditionally still tend to choose a particular asset class and diversify between different countries. As a result, it is also relevant to evaluate the comovements between EU stock and between government bond markets and provide recommendations of whether regional diversification inside the market of the same asset class is a reasonable solution in present environment.

The comovements between financial markets of EU countries have been analyzed by multiple authors. Despite of that, there is a tendency of only analyzing comovements of stock and bond market indices in major economies not taking into account the rest of EU, especially the new members and the members not belonging to EMU. Due to ongoing financial crisis and decreased credit rates of countries themselves, the prices of government securities tend to increase. This is especially a tendency for smaller and more risky EU economies, which need to pay risk premium for the possibility to borrow. It might fascinate investors and trigger them withdrawing the money from companies and investing into government bonds as still seen less risky. The problem here is that there

is not enough studies implemented for evaluation of how those smaller or riskier financial markets are connected with major markets, or how the stock markets react to changes in government bond markets and vice versa. The lack of answers for tendencies of comovements between financial markets of all EU countries, specifically in time of financial stress in the markets, infuses the **purpose** of this research. Examination of the linkages between stocks, bonds and stock-bond markets in EU countries and evaluation of those linkages is expected to favor investors with valuable information concerning their portfolio formation and the exchange of risk and return. This is especially beneficial in time of ongoing financial turmoil in EU.

2.3. The Empirical Research Hypotheses

One of the initial stages of investigation of the comovements between stock and government bond markets should be the formulation of research hypotheses. Due to the relevance, purpose and the objectives of the research, four hypotheses were formulated. The approval or denial of the first hypothesis is intended to determine the comovements in equity markets, so the hypothesis is formulated as follows:

Hypothesis 1: The comovements between returns on main stock indices in the financial markets of EU countries are strong.

In the context of globalized financial world, integration and strong connection between most of the equity markets is usually assumed to be unquestionable. Despite of common references, the fairness of this statement has been proved mostly by analyzing the data of biggest, most developed equity markets. Not taking into account changes in smaller, less developed and less liquid EU equity markets makes the overall tendency questionable and the results hard to be broadly adapted. This fact has determined the raise of the first hypothesis. This hypothesis is approved if more than 50% of correlation coefficients obtained indicate medium or stronger correlation (are higher than 0.5). In addition to that, the coefficients calculated need to be statistically significant at 0.05 level of confidence.

Similarly as the first hypothesis was raised for determination of comovements between equity markets in EU countries, the second hypothesis raised refers to comovements in bond markets and is formulated as follows:

Hypothesis 2: The comovements between returns on main government bond indices in the financial markets of EU countries are strong.

Even though government bond markets are traditionally assumed to be less volatile and providing more stable returns, similarly as equity markets, these markets of EU countries also have been experiencing fast integration in between. Government bond markets are usually seen to be the safest way of investment, they tend to be chosen by risk-averse investors. As most of the researches

of government bonds are mostly implemented in the US (Reilly et al, 1992; Clare and Lekkos, 2000; Becker and Ivashina, 2013) and the ones implemented in EU do not provide unified results (Black et al, 2010; Brennan et al, 2011), the question of government bond market comovements in all EU countries stays unanswered. Similarly as for hypothesis raised for evaluation of comovements in stock markets, this hypothesis is approved if more than 50% of correlation coefficients indicate medium and higher relationship ($\rho \geq 0.5$) and these coefficients are statistically significant at 0.05 level of confidence.

The determination of comovements inside stock and government bond markets in EU countries is beneficial for regionally diversifying investor. Despite of that, another strategy, diversification between asset classes, requires the knowledge about relationships between stock and government bond markets in EU countries. Due to this fact, the third hypothesis was raised:

Hypothesis 3: The comovements between returns on main stock and government bond indices in the financial markets of EU countries are strong.

With the ongoing convergence of stock and government bond markets investors need to take a decision whether diversification between asset classes is more beneficial than international/regional diversification in the same asset class. With global markets of the same asset class becoming more and more integrated, an increased correlation between stock and government bond markets in the same EU country would leave not much space for investor to take beneficial capital allocation decisions. Furthermore, if this relationship was not anticipated in advance, investor might experience big losses, so the evidence of the comovements between the markets is of high importance. The hypothesis is accepted if more than 50% of correlation coefficients calculated indicate medium or strong relationship between the markets and these correlations are statistically significant at 0.05 level.

Finally, it was stated in the first part of the paper that the dependence between stock and bond markets tends changing in times of financial stress. In order to check the fairness of this statement, the fourth hypothesis was formulated:

Hypothesis 4: The comovements between returns on main stock and government bond indices in the financial markets of EU countries became stronger in the period of financial crisis from 2008.

Even though the comovements between the markets are relevant during the whole period of research, the financial turmoil from the beginning of 2008 is usually claimed to have caused a significant change in the relationships between stock and government bond markets. If in 2009 central banks of EU countries implemented supportive measures for stabilization of investments and economy as a whole, new intensity to the crisis was given in 2010-2011. This new stage of crisis has appeared in government bond markets but later spread to other parts of EU financial system, especially equity markets, making the stock market indices go down and forcing investors to stress

about the quality, liquidity and future of their investments. Despite of that, the last study of ECB (2012) shows that the impact of sovereign debt crisis was limited for financial markets: national stock price indices seem to be reacting to both international and firm-specific shocks in the usual way, without any overwhelming country specific influence. This fact makes the approval or denial of the fourth hypothesis of a big importance. This hypothesis is confirmed if correlations between stock and government bond markets increased in more than 50% of EU countries when reducing the calculation period to 2008-2013.

The study for confirmation or rejection of these hypotheses is being implemented in different stages based on the research methodology.

2.4. The Empirical Research Logic, Stages and Methods

Before the start of the research it is necessary to compile a plan. Table 6 represents the logical sequence and the stages of the research.

Table 6

Research Stages and Methods Used for Hypothesis testing

Stage	Content of the stage	Hypothesis tested	Method used
Preparatory	Choice of market indices Choice of research period Collection and systematization of data	-	-
1	Calculation of monthly returns. Evaluation of their volatility and distribution	-	Logarithmic return/Standard deviation/Skewness/Kurtosis
2	Investigation of relationship between stock indices in EU countries. Evaluation of their statistical significance	H1	Correlation coefficient/ *Fisher's null hypothesis* testing
3	Investigation of relationship between government bond indices in EU countries. Evaluation of their statistical significance	H2	Correlation coefficient/ *Fisher's null hypothesis* testing
4	Investigation of relationship between stock and government bond indices in EU countries. Evaluation of their statistical significance	H3	Correlation coefficient/ *Fisher's null hypothesis* testing
5	Investigation of dynamics of relationship between stock and government bond indices in EU countries	-	Rolling correlation coefficient/ Arithmetic average/ Standard deviation/ Skewness/ Kurtosis
6	Investigation of relationship between stock and government bond indices in EU countries in 2008-2013. Evaluation of their statistical significance	H4	Correlation coefficient/ *Fisher's null hypothesis* testing
7	Interpretation of the results obtained and comparison with other researches	-	-

Source: compiled by the author

The preparatory stage is one of the most important stages of the research. It includes the choice of data analyzed together with the choice of research period. Furthermore, this stage also includes the collection and systemization of data. After the implementation of this stage it is possible to characterize the data sample and to exclude the limitations of the research.

The first stage of the research is designed for processing the data collected. First of all, the raw data of stock and bond indices is transformed to annual returns on these indices. Later the returns on market indices in every single EU country are characterized by several statistical measures, such as

average, standard deviation (reflecting the volatility of stock and bond market returns), skewness and kurtosis (reflecting the distribution of these returns).

Stages 2-6 are designed to investigate the relationships between financial markets in EU countries. Methods used for this investigation in Stages 2-4 and 6 include calculation of correlation coefficients and testing their statistical significance by approving or rejecting *Fisher's null hypothesis*. Stage 2 is designed for investigation of comovements between equity markets in EU countries. Due to this fact, in this stage the first hypothesis is tested. Similarly, in stage 3 comovements between bond markets in EU countries are evaluated by testing the second hypothesis raised. Stages 4 and 5 are both intended for evaluation of comovements between stock and bond markets in the same EU country. The difference between these stages lies in the fact that in Stage 4 correlation coefficients between stock and bond markets are calculated and their statistical significance is evaluated. These actions lead to confirmation or rejection of the third hypothesis. In addition, stage 5 provides an insight of the volatility of correlations between stock and bond markets. This is done by using rolling correlation windows and statistical measures (average, standard deviation, skewness and kurtosis) for evaluation of their changeability during the sample period. Stage 6 is intended to verify the statement about modification of relationships between financial markets in times of financial stress. For this reason the comovements between stock and bond markets in EU countries in the period of the last 5 years, referred to as the *financial crisis* (Blundell-Wignall, Atkinson, Lee, 2008; Jickling, 2010), are estimated and the fourth hypothesis is tested.

The final stage of the research is designed for the generalization and the interpretation of the results obtained. These results are compared with the results derived from other researches and the common tendencies together with main differences are excluded.

The implementation of the preparatory stage is delineated in the following section.

2.5. The Empirical Research Data Sample

This research involves 27 European countries, the members of the European Union. Every member state has its own stock and government bond markets with different market indices, there should be 54 market indices to analyze. Despite of that, the Estonia's and Malta's government bond markets are not analyzed due to the fact that there are no bonds issued that could comply with the definition of long-term bonds issued for convergence purposes. As a result of that, government bond market indices are not calculated in these countries.

One of the first tasks in the research preparatory stage is *the choice of stock market indices*. Comparison of changes in stock and bond markets might be implemented by using several types of indices. It is a question of a big significance how to choose the proper market indices to reflect the situation in the market. This might be done by several techniques. Some of the previous authors

selected the stock and bond indices based on their popularity in the earlier literature on stock-bond relations (Cappiello, 2006; Connolly, 2007; Viitanen, 2011). The list of stock market indices used can be seen in Table 7.

Table 7

Stock market indices used in the research

COUNTRY	EXCHANGE	INDEX USED	TYPE		DATA AVAILABLE
Austria	Vienna Stock Exchange	ATX	Price	Blue chip	FULL
Belgium	Euronext Brussels	BEL-20	Price	Blue chip	FULL
Bulgaria	Bulgarian Stock Exchange	BSE SOFIX	Price	Broad market	From 2000-10-01
Cyprus	Cyprus Stock Exchange	TOTMKCP	Price	Broad market	FULL
Czech Republic	Prague Stock Exchange	PRAGUE SE PX	Price	Blue chip	From 1994-04-01
Denmark	Copenhagen Stock Exchange	OMXC20	Price	Blue chip	FULL
Estonia	Tallinn Stock Exchange	OMXT	Total return	Broad market	From 1996-06-01
Finland	Helsinki Stock Exchange	OMXH25	Price	Blue chip	FULL
France	Euronext Paris	CAC40	Price	Blue chip	FULL
Germany	Deutsche Börse Group	DAX30	Price	Blue chip	FULL
Greece	Athens Stock Exchange	GD.AT	Price	Blue chip	FULL
Hungary	Budapest Stock Exchange	BUXINDX	Price	Blue chip	FULL
Ireland	Irish Stock Exchange	ISEQ GENERAL	Price	Blue chip	FULL
Italy	Borsa Italiana	MIB40	Price	Blue chip	FULL
Latvia	Riga Stock Exchange	OMXR	Total return	Broad market	From 2000-01-01
Lithuania	Vilnius Stock Exchange	OMXV	Total return	Broad market	From 2000-01-01
Luxembourg	Luxembourg Stock Exchange	LuxX	Price	Blue chip	From 1999-01-01
Malta	Malta Stock Exchange	MSE	Price	Broad market	From 1995-01-01
Netherlands	Euronext Amsterdam	AEX.AS	Price	Blue chip	FULL
Poland	Warsaw Stock Exchange	WIG	Total return	Broad market	FULL
Portugal	Euronext Lisbon	PSI-20	Price	Blue chip	FULL
Romania	Bucharest Stock Exchange	BET-10	Price	Blue chip	From 1997-09-01
Slovakia	Bratislava Stock Exchange	SXSAX16	Price	Blue chip	From 1993-09-01
Slovenia	Ljubljana Stock Exchange	MSSLVNL	Price	Blue chip	From 2000-06-01
Spain	Madrid Stock Exchange	IBEX35	Price	Blue chip	FULL
Sweden	Stockholm Stock Exchange	OMXS30	Price	Blue chip	FULL
United Kingdom	London Stock Exchange	FTSE100	Price	Blue chip	FULL

Source: compiled by the author based on *Thomson Reuters* and *FESE* data.

Equity market indices are usually categorized as being total return or price indices. For this study it was decided to analyze benchmark indices of both stock and bond markets. They are used as standards that serve as a point of reference for evaluating the markets. There exists a variety of national stock market indices because several depending on the methodology used for calculation and a party of maintenance. The base criteria for choosing was the stars assigned to the indices by

Thomson Reuters database, reflecting the quality and the usability of the data. The highest quality of the indices is assigned to benchmark ones.

Another way of classification stock indices is their division to price and return indices. Even if return indices reflect overall performance of companies (including dividends), the main benchmark stock indices in the world such as *ATX* (Austria), *DAX* (Germany), *OMXSPI* (Sweden) are price indices (Yahoo Finance). The goal of this study is to analyze the indices that most accurately reflect changes in stock and bond markets, so it was decided to choose price indices. These indices exclude dividends paid and only reflect the price of the stocks. For some countries the choice of these indices wasn't possible (see *2.7. Limitations of the Empirical Research*).

Stock market indices can also be classified as *broad market* or *blue chip* indices. Broad market indices are designed to reflect the movements of the entire market. On the contrary, blue chip stock indices represent financially stable companies that provide good returns for investors and are considered to be desirable investments. Blue chip indices might be less profitable since they reflect the higher range of mature companies with a relatively lower growth potential. Nevertheless, blue chip companies tend to perform similarly to the economy as a whole, so the performance of a blue chip index is usually considered as a meter of country's economic strength. Due to this fact, another criteria for the choice of stock market indices was selection of blue chip ones. Yet, it was not possible for all the countries analyzed since some of them only calculate broad market indices.

The choice of value of stock indices is also significant. Stock indices are quoted in several different prices (open, average, close, adjusted close). For stock market indices the adjusted close price was chosen. This price is a stock's closing price every day that has been adjusted to any corporate actions occurring prior to the next day's opening of the market. This price is most commonly used when performing analysis of historical returns.

Similarly as in equity markets, the data reflecting the performance of bond markets needed to be chosen. There exists a variety of bond market indices. Even though stocks are the instrument of capital while bonds are the instrument of debt, the value of corporate bonds is also affected by company-related factors. The price of government bonds, on the contrary, depends on more global factors and represents the risk of the country itself. This is relevant when analyzing connections between different financial markets in EU countries. In addition to that, government bonds used to represent a minimum risk for investors as being totally backed up by the confidence in state. Finally, in the context of financial crisis a flight-to-quality was commonly argued to be triggered, leading to intensified purchase of government bonds rather than investing in equity markets. Due to the reasons mentioned, the use of government bond market indices is seen as the most adequate way for evaluation of the comovements between stock and bond markets. The full list of bond market indices used can be seen in Table 8.

Table 8

Bond market indices used in the research

COUNTRY	INDEX USED	ISSUER	TYPE	MATUR.	CURR.	DATA AVAILABLE
Austria	OE BENCHMARK	Gov.	Clean Price	10 year	€	Full
Belgium	BG BENCHMARK	Gov.	Clean Price	10 year	€	Full
Bulgaria	BOFA ML EUR EMRG SOV BULGARIA	Gov.	Total Return	All	€	From 1996-01-01
Cyprus	CGBI WBIG CYPRUS DOM.SOV.	Gov.	Total Return	All	€	From 2002-04-01
Czech Republic	CZ BENCHMARK	Gov.	Clean Price	10 year	CK	From 2000-05-01
Denmark	DK BENCHMARK	Gov.	Clean Price	10 year	DK	Full
Estonia	-	-	-	-	-	-
Finland	FN BENCHMARK	Gov.	Clean Price	10 year	€	Full
France	FR BENCHMARK	Gov.	Clean Price	10 year	€	Full
Germany	BD BENCHMARK	Gov.	Clean Price	10 year	€	Full
Greece	GR BENCHMARK	Gov.	Clean Price	10 year	€	From 1999-04-01
Hungary	HN BENCHMARK	Gov.	Clean Price	10 year	HUF	From 1999-02-01
Ireland	IR BENCHMARK	Gov.	Clean Price	10 year	€	Full
Italy	IT BENCHMARK	Gov.	Clean Price	10 year	€	Full
Latvia	BOFA ML EUR EMRG SOV LATVIA	Gov.	Total Return	All	€	From 2005-01-01
Lithuania	BOFA ML EUR EMRG SOV LITHUANIA	Gov.	Total Return	All	€	From 2005-01-01
Luxembourg	BARCLAYS EURO AGG LX ISSUERS	All	Total Return	Close to 10 year	€	From 2004-10-01
Malta	-	-	-	-	-	-
Netherlands	NL BENCHMARK	Gov.	Clean Price	10 year	€	Full
Poland	PO BENCHMARK	Gov.	Clean Price	10 year	PLN	From 2001-01-01
Portugal	PT BENCHMARK	Gov.	Clean Price	10 year	€	From 1993-08-01
Romania	BOFA ML EUR EMRG SOV ROMANIA	Gov.	Total Return	All	€	From 2001-08-01
Slovakia	BOFA ML SLOVAKIA GOV	Gov.	Total Return	All	€	From 2005-01-03
Slovenia	BOFA ML SLOVENIA GOV	Gov.	Total Return	All	€	From 2008-01-02
Spain	ES BENCHMARK	Gov.	Clean Price	10 year	€	Full
Sweden	SD BENCHMARK	Gov.	Clean Price	10 year	SK	Full
United Kingdom	UK BENCHMARK	GOV.	Clean Price	10 YEAR	£	Full

Source: compiled by the author based on *Thomson Reuters* and *FESE* data.

When choosing a government bond index, it is also an important decision to select from total return and price indices. S. J. Kim et al (2006), L. Cappiello et al (2008), D. G. Baur (2009) use sovereign total return bond indices while M. Andersson et al (2004), H. Bessembinder et al (2008) use price indices. It was decided to collect the data of clean price bond market indices in this research

where possible. These indices exclude the interest accrued on the bond and only take into account the price change. Despite of that, price indices of stock markets are used in the research, so it is more accurate to use price indices of government bonds also. However, it is necessary to mention that not all the countries quote their government bond market indices on clean price. In case there is no government market index quoted in clean price, a total return index is used for calculations. Government bond market indices reflect the moves of bonds with different maturities from 1 to 30 years. When choosing the index for analysis it is important to decide on the maturity reflected. According to D. G. Baur and B. M. Lucey (2006), long term government bonds should be selected over short term government bonds because they can be considered as closer maturity substitutes to stocks and monetary policy operations are more likely to have an unclear influence on short-term rather than on long-term government bonds.

The same opinion is held by S. J. Kim et al (2006). They state that government bonds with more than 10 years to maturity should be used to effectively match their duration with stocks, often generally viewed as long-term investments. On the contrary L. Cappiello et al. (2008) use five-year average maturity indices. L. Li (2002), M. Andersson et al. (2004) and other authors use 10 year government bond indices as the most appropriate for comparison with stocks, this duration is also most commonly used as the benchmark. Due to that, when implementing this study, mostly 10 year government bond market indices are used. Some countries do not provide the data of 10 year maturity government bond indices. In that case the all maturity bond market indices are used for the analysis.

The chosen currency for government bond market indices was mostly euros. The exception was made for several countries with the prerogative to benchmark government bond indices.

After choosing the indices for reflection of changes in EU countries' financial markets, the further step is choosing *research period* for evaluation. Studies of stock and bond markets, implemented by different authors, concentrated on various periods. J. T. Scruggs and P. Glabadanidis (2003) used monthly data for the period 1953-1997. D. G. Baur (2009) covered 20 year period from 1989 February to 2009 February, but he used weekly index returns. S. J. Kim et al. (2006) used the data of 10 years, but calculated the daily returns. L. Cappiello et al. (2008) covered 15 years with weekly frequency but they also claim that there is no need to take into account the structural break in the conditional correlations caused by introduction of the euro in 1999 January. This decision would extremely shorten the research period and the correlations obtained might have been less significant, so it was not taken. Finally, 20 year research period from February 1993 to February 2013 was chosen for this study. This has been done in order to be able to examine the situation during both relatively volatile and relatively more stable periods. Since the analysis covers all 27 European Union countries, a longer period would have extremely widened the study. Despite of that, data for the whole period was not available for some countries.

In order to obtain more comparable results, the research of comovements of stock and government bond markets will also be implemented in shorter period: January 2008-2013. This is done by because of two main reasons. Firstly, this is the date from which the data of stock and government bond indices is available for every EU country. Secondly, the period from 2008 is considered as time of the crisis in financial markets. It is widely stated in financial literature that relationship between stock and government bond markets tend to change its direction in times of financial turmoil. For examination of this fact and the approval or denial of the *Hypothesis 4*, this shorter period of analysis is also chosen.

The *collection of data* was mainly implemented by using historical data of stock and government bond indices from *Thomson Reuter's* database. The data collected of daily values of the indices. According to C. Alexander (2001) to obtain statistical estimate of correlation, the historic data on the two asset returns need to be of the same frequency or measured at synchronous points in time. There may be a problem with obtaining the data at exactly the same time for cross-market correlation estimates. For calculation of returns, a monthly frequency was chosen. This was done due to several reasons. Firstly, wide range of analyzed countries would make it very difficult to systemize daily or even weekly data for all the countries. If data on one series is measured before the data on the other, correlation estimates may be biased. It would be extremely difficult to synchronize daily or even weekly data of all 27 countries' stock and bond indices. Secondly, market indices reflect situation in different stock exchanges and the trading days do not match. This would lead to a necessity to delete the day from calculation if in any of 27 countries the trading was not valid that specific day or otherwise the data would not reflect the reality.

Finally, a fact of high significance is that even though clear criteria was set for the data to be chosen, it was not possible to fulfill those criteria in all the markets analyzed. The limitations appearing due to lack of data available are presented in the following section.

2.6. Methods of the Empirical Research

2.6.1. Calculation Methods and Characteristics of Returns

This stage of the research provides the methods for calculations of returns on market indices and the characteristics of these returns. The benefit of using returns on market indices rather that their value is a normalization: comparable scale enables to evaluate the relationship between indices despite of their unequal values. This is a requirement for multidimensional statistical analysis.

For calculation of monthly returns, it is needed to select the reference date. Most commonly the prices of index on the first trading day of the month or the prices in the middle of the month are used. It was decided to use the prices of indices at the first trading day of the month as deciding on the middle of the month date might have been ambiguous.

When calculating the changes in index value, monthly or year-to-year returns are mostly used. The latter helps to avoid seasonality and may be beneficial for having a continuous basis for returns. Despite of that, this method of calculation does not reflect up-to-date correlations as the estimations of coefficients are based on the returns obtained during the years up to the calculation date, so monthly returns on indices are calculated in this research. Monthly returns on stock and bond market indices were assumed to be the change in index value between the first quoting day of the month and the first quoting day of the previous month.

These monthly returns might be calculated in several ways. The simplest way to do that is to calculate an arithmetic return (1 formula).

$$Arithmetic\ Return = \frac{P_{t+1} - P_t}{P_t} \tag{1}$$

Monthly return would be calculated as the difference of the index value between the first day of the month and the first day of the previous month, divided by the value on the first day of the previous month. Despite of arithmetic return's popularity in economic calculation, in this study a different method for calculation of returns is used.

Financial asset prices are random, not deterministic variables, so the fluctuations in their prices during a short holding period are often assumed to be lognormal random variables. According to C. Alexander (2001) because of this reason returns of financial assets should be measured by the difference in log prices, which would be normally distributed. T. Viitanen (2011) also calculated the logarithmic returns on indices by taking first difference of the natural log of the daily closing prices. Firstly, if it is assumed that prices of securities (or values of the indices) are distributed log normally, and then $log\ (1+r_i)$ is also normally distributed because (2):

$$1 + r_i = \frac{p_i}{p_j} = \exp^{\log(\frac{p_i}{p_j})} \tag{2}$$

Secondly, because of *approximate raw-log equality*, when returns are very small, the following approximation ensures they are close in value to raw returns (3):

$$\log(1+r) \approx r, r \leq 1 \tag{3}$$

Thirdly, it is easier to calculate compounding returns. Fourthly,there exists a *mathematical ease*, because (4):

$$e^x = \int e^x dx = \frac{d}{dx} e^x = e^x \tag{4}$$

Finally, *numerical stability*: addition of small numbers is numerically safe, while multiplying small numbers is not a subject toarithmetic underflow (Hudson and Gregoriou, 2010). Because of the reasons mentioned, this study will be implemented by using logarithmic returns (5).

$$Logarithmic\ Return = \ln\left(\frac{P_{t+1}}{P_t}\right) \quad (5)$$

where: P_{t+1} – is the index value in month *t+1;*

P_t – the index value in month *t*

Logarithmic returns were calculated for both stock and government bond indices in all the 27 countries. The returns on investments are usually compared on annual basis. Due to this fact monthly returns calculated were multiplied by 12 (Figure 7). Full data is available in Appendix 7.

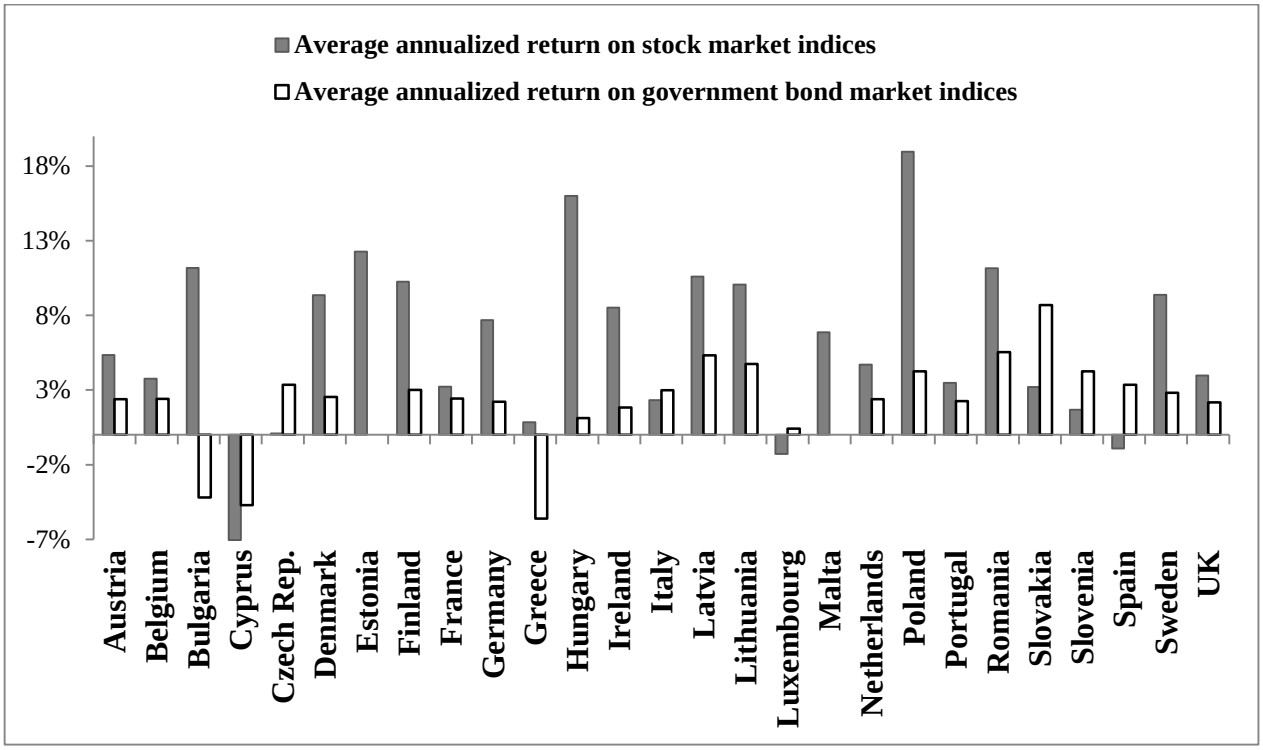

Figure 7. Average annualized returns on the stock and government bond market indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

Firstly it should be noticed that most of the annual returns on indices during the research period were positive with the exceptions in Cyprus, Bulgaria, Greece, Luxembourg and Spain. It reflects the fact that Cyprus was the only country with overall negative performance in both stock and government bond markets. It is also not a surprise that the smallest annual return on government bond index during the research period was captured in Greece. Bulgaria's government bonds index lost half of its value in July 2012 and this mainly influenced the calculated returns. Luxembourg's and Spain's average annualized stock market indices during the research period were also negative. It should be noticed that overall in most of the cases annualized returns on equity indices exceeded

returns on government bond indices with only few exceptions mentioned. This coincides with the financial theory, constituting that returns on stocks should be higher than returns on bonds due to excessive risk undertaken and the required premium for that.

Highest returns on government bond indices were recorded in new EU countries (Slovakia, Romania, Latvia, and Lithuania). The governments of these countries, having bigger risk than old members, needed to pay more for money than, for example, Austria, Belgium or Germany.

On the opposite side of the research, it is necessary to look at the volatility of market indices analyzed as being the measure of the dispersion in a probability density. The most common measure of dispersion is the *standard deviation* of a random variable (*σ)*. It is hard to predict price variations of financial assets so it is usually assumed that successive returns are relatively independent of each other. This leads to increased uncertainty: with the increase of the holding period the distribution will become more dispersed and its variance will increase (Alexander, 2001). Thus, in financial markets annual volatility is defined as follows (6):

$$Annual\ volatility = (100\sigma\sqrt{A})\ \% \tag{6}$$

where A is an annualizing factor, the number of returns per year.

The formula 2.6 was used for evaluation of volatility of returns on stock and government bond market indices in EU countries. Again the returns were used instead of the value of indices due to normalization. The distribution of standard deviations of returns on stock and government bond indices is presented in Figure 8.

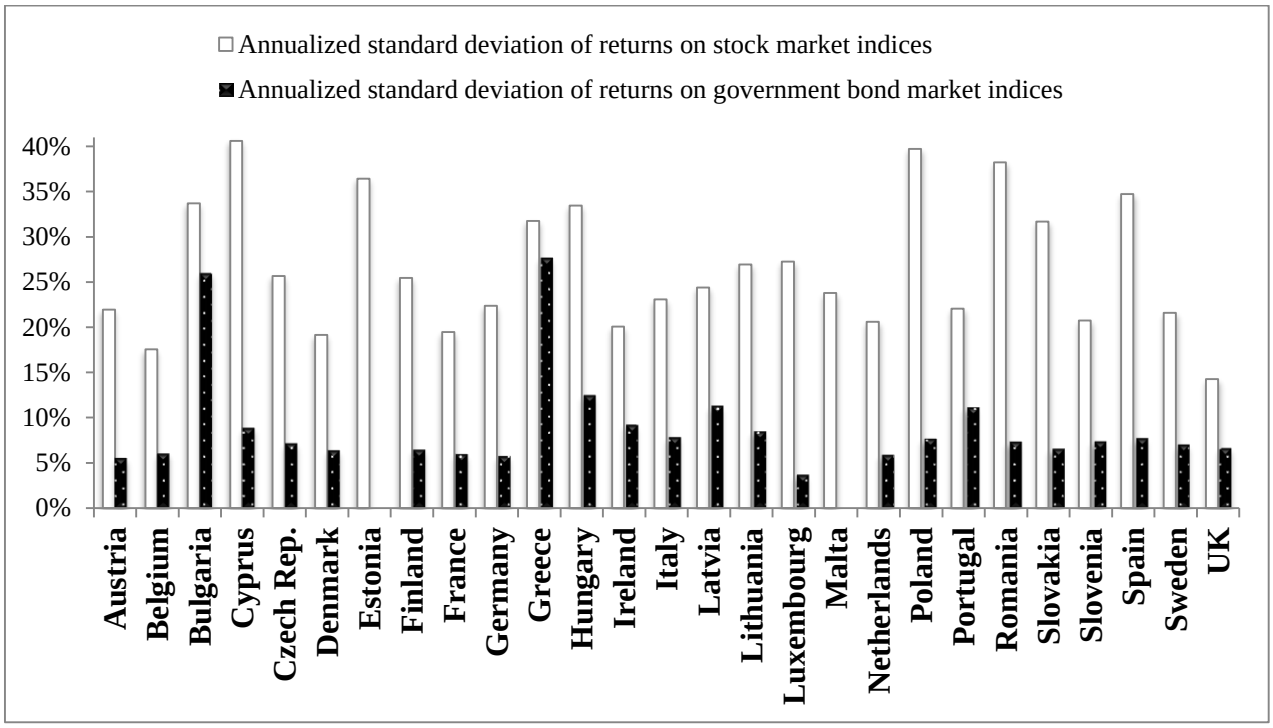

Figure 8. Average annualized standard deviations of returns on stock and government bond market indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

The data shows that volatility of the returns on stock indices in most of the cases exceeds volatility of returns on government bond indices. Again, the highest annualized standard deviations of returns on stock indices were recorded in Cyprus, Poland, Estonia, Romania, Spain and Bulgaria while the lowest were in developed old members of the Union: the UK, Belgium, Denmark, France (below 20%). Annualized standard deviations of returns on government bond indices in all countries were much smaller and in most of the cases didn't exceed 10%. The exceptions were Greece and Bulgaria. Bulgaria's situation should be evaluated with caution because the data available for this country's government bond market index only covers the time from 2005, so the volatility ratio might be biased. The volatility of Greece's government bond index was higher than the volatility of most of the stock indices of other EU countries, so it can be clearly seen that investors find Greece's government not trustworthy and this is reflected in fluctuations of the government bond market index. On the contrary the returns of bond market indices in countries like Austria, Germany and the UK were extremely small and represented minimal risk during the period reflecting the minimal variations of confidence of investors in these government bond markets.

For evaluation of distribution of the returns, two other characteristics were also calculated: the skewness and the kurtosis of the returns. The skewness measures the asymmetry of the probability distribution of a random variable and can have both positive and negative values with negative skew representing that the *tail* on the left side of the probability density function is longer than the right side and most of the values are plotted right of the mean. On the contrary, positive skewness is associated with longer *tail* on the right side and most of the values lying to the left of the mean. A zero skewness value indicates that the values are relatively evenly distributed on both sides of the mean, typically implying a symmetric distribution.

For most of the returns on stock and government bond indices, the *skewness* was negative or close to zero (Appendix 8). It represents the fact that the distribution of returns is rather symmetrical with a bigger density above the average. As the exceptions from that should be mentioned Spain with its extremely big negative coefficient revealing that most of the values of the distribution were plotted in the right from the mean and were not distributed symmetrically. The opposite of that were returns on Slovakia's stock index, mainly plotted on the left side from the mean. The skewness parameter all in all was lowest for government bond indices in new EU countries. This result might reflect the fact that there is the lack of data on government bond indices in these countries. In general, when looking at the countries with full data range, the skewness of the returns of government bond indices was closer to zero, indicating that these returns were more symmetrically distributed than the ones of stock indices.

Other parameter, calculated for returns on stock and government bond indices, was *kurtosis*. This measure of *peakedness* of the probability distribution of a random variable is also used to describe the shape of a probability distribution and may be referred to as *the volatility of volatility*. For analysis of historical returns kurtosis helps to determine the level of risk for a security. In case of *leptokurtic* distribution, the security will have a relatively low amount of variance, because return values are usually close to the mean. This fact is beneficial for risk-averse investors willing to avoid big, irregular fluctuations of returns on their portfolio returns as they should structure their investments to produce a leptokurtic distribution (with a more acute peak around them and fatter tails). *Mesokurtic* distribution refers to higher standard deviation and the distribution of the returns being closer to normal one (Fabozzi et al, 2008).

When analyzing the kurtosis of the data it was noticed the same tendency as with skewness: for older EU members with more stable economies the parameters were closer to zero (*mesokurtic*) referring to normal distribution (Appendix 9). Parameters of returns on government bond indices were noticed to be closer to zero than parameters of stock indices. Distributions with positive excess kurtosis (leptokurtic) were mostly obtained for the bond indices of new EU countries, and stock market indices of Spain and Slovakia. Usage of these parameters helps to draw up the initial view of the relationship between stock and bond markets in different EU countries. Markets with high positive and negative parameters should be less correlated with other markets, having parameters close to zero. This happens due to the lack of normal distribution (it should be assumed that returns on most liquid indices are normally distributed). It should be beneficial for investor who wants to regionally diversify or use a diversification between different asset classes. This statement will be further checked with the calculation of correlations between different market indices.

2.6.2. Methods for Estimation of Comovements between Stock and Bond Markets

As one of the simplest and most popular ways for estimation of comovements between two variables, Pearson correlation coefficient was chosen for this research. This measure of strength and direction of the linear statistical relationship between two variables is influenced by the distribution of the independent variable in the sample and is defined as follows (7):

$$\rho_{xy} = \frac{Cov(x, y)}{S_x S_y} \tag{7}$$

Where: Cov(x,y) – covariance between the log returns of indices;

S_x – standard deviation of log return on first index;

S_y – standard deviation of log return on second index.

If the correlation coefficient between two variables is equal to zero, these variables are statistically independent. On the contrary, a value close to 1 (-1) indicates a very strong linear positive (negative) relationship between two variables (Table 9).

Table 9

The interpretation of correlation analysis results

The value of correlation coefficient	Interpretation
From 0.7 to 1 (from -0.7 to -1)	Strong positive (negative) linear relationship
From 0.5 to 0.7 (from -0.5 to -0.7)	Medium positive (negative) linear relationship
From 0.3 to 0.5 (from -0.3 to -0.5)	Weak positive (negative) linear relationship
From 0.0 to 0.3 (from -0.3 to 0.0)	Very weak positive (negative) linear relationship

Source: compiled by the author according M. Mudelsee (2003).

Calculation of correlations itself is not a sufficiently reliable measure of relationship between market indices. According to N. Fenton and M. Neil (2013), confidence in a relationship is formally determined not only by the correlation coefficient itself but also by the number of pairs in the data. If there are very few pairs the coefficient needs to be very close to 1 or –1 for it to be deemed 'statistically significant', but if there are many pairs then a coefficient closer to 0 can still be considered highly significant. One of the most common measures of statistical significance of empirical analysis is the testing of *Fisher's null hypothesis* with a two-tailed test. It is appropriate for comparing two samples where the important variables are impossible to control. The testing starts with the formulation of the null hypothesis to check:

H_0: $\rho_{xy} = 0$,— correlation is statistically insignificant;

H_1: $\rho_{xy} = 0$, — correlation is statistically significant, the variables are dependent.

In order to check the validity of the null hypothesis a level α of statistical significance needs to be chosen *(Type 1 error rate).* This is the probability of rejecting a given null hypothesis in favor of a second alternative hypothesis while the null hypothesis is correct. α is a fixed number chosen, usually 0.05 or 0.01.When evaluating the correlations obtained, a level of significance chosen is 0.05.

$H_0$is rejected if $p < \alpha$ and H_0 is accepted if $p \geq \alpha$.

A number *p* is called *p-value*. It is the probability of obtaining a test statistic at least as extreme as the one that was actually observed, assuming that the null hypothesis is true. If the *p-value* is less than the significance level, indicating that the observed result would be highly unlikely under the null hypothesis, the null hypothesis is rejected. This reflects the validity of H_1 and the fact that correlation is statistically significant. As it was already mentioned, *p-value* is a number and can be easily generated by statistical programs such as *Statistical Package for the Social Sciences (SPSS).*

The correlation between two variables does not have to be high in order to be statistically significant. On the contrary, a high correlation might not always be statistically significant due to the

sample size. As a result of that, the significance of correlation coefficients between security market indices in EU countries is checked in this study.

The calculation of correlation coefficients between stock and bond market indices is implemented towards different directions:

1. *Correlation coefficients between stock indices in EU countries in 1993-2013;*
2. *Correlation coefficients between government bond indices in EU countries in 1993-2013;*
3. *Correlation coefficients between stock and government bond indices in the same EU country in 1993-2013;*
4. *Rolling window correlations between stock and government bond indices in the same EU country in 1993-2013.*It should be analyzed whether it is reasonable to assume that those correlations are constant or time varying. For this purpose by using 8 formula moving averages of correlations are calculated:

$$\rho_T = \frac{\sum_{t=T-m}^{t=T-1} x_t y_t}{\sqrt{\sum_{t=T-m}^{t=T-1} x_t^2 \sum_{t=T-m}^{t=T-1} y_t^2}} \tag{8}$$

Where x_t and y_t are return series of the stock and bond indices;

m is the length of the window used.

According to J. H. Jia and R. Adland (2003), the length of the window *m* determines the smoothness of the temporal movements of the data. Generally, a shorter window width will produce more volatile time series of sample correlations but will give a better representation of the contemporaneous correlation. The drawback of using historical correlations is that the time series of correlations might exhibit so-called "ghost features" as the impact of major market movements is reflected in the correlations up to *m* months after they occurred. Alexander (1998) also notices that even with two closely related series the correlation estimates will tend to appear more stable with the increase of period *m*. The most common adaptation of rolling windows when using calculated monthly returns includes 12 month period. Due to the practice already implemented by other authors, the 12 month rolling window is also used in this research.

5. *Correlation coefficients between stock and government bond indices in the same country in January 2008-February 2013.* In the end of the analysis the shorter period is chosen because of two following reasons. Firstly, this is the period from which there is the data available for the values of stock and bond market indices in all the research countries. Secondly, this is usually considered as the period of the financial crisis, and in the context of crisis still on-going, it is beneficial to investigate the changes of the comovements between the markets.

The calculation of the correlations inside the markets of the same asset class in different EU countries and between the different assets classes in the same country is expected to lead to the conclusions of either the markets in EU countries are highly connected with each other. Despite of that, the conclusions about that can only be made bearing in mind the limitations of the research.

2.7. Limitations of the Empirical Research

This research is intended to cover securities markets of all the 27 EU countries. A high scope of the countries analyzed and various data needed leads to several limitations of the research.

First limitation of the research covers the availability of data of stock market indices in EU countries. Even though price indices were chosen for evaluation of the stock markets of EU countries, for several countries (Estonia, Latvia, Lithuania and Poland) it was not possible to find data on them, so total return indices were used. Similarly, even though the study focuses on blue chip stock market indices as the ones considered to be the meter of country's economic strength, it was not possible to collect the data of blue chip stock market indices for all the countries. For evaluation of stock markets in Bulgaria, Cyprus, Estonia, Latvia, Lithuania, Malta and Poland broad market indices were used.

Second limitation comprehends the data of government bond market indices. Estonia and Malta did not have government bonds that comply with the definition of long-term bonds, so government bond market indices are not calculated in these countries. This limits the analysis of government bond markets and the comovements between stock and government bond markets to 25 EU countries. In addition, Luxembourg's long-term government bond indices are only calculated starting mid-May 2010. Before, the Luxembourg Government did not have outstanding long-term debt securities with a residual maturity of close to ten years. Therefore, the index of long-term bond(s) issued by a private credit institution with a residual maturity close to 10 years is presented for the period up to mid-May 2010 and is thus not fully harmonized for that period. Moreover, it was not possible to get the data of clean price government bond market indices for all the countries. As a result of that for Bulgaria, Cyprus, Latvia, Lithuania, Luxembourg, Romania, Slovakia and Slovenia total return bond market indices were used for calculations. Similarly, several countries did not satisfy the criteria of indices reflecting the changes in 10 year government bond markets. For the analysis of bond markets in Bulgaria, Cyprus, Latvia, Lithuania, Luxembourg, Romania, Slovakia and Slovenia *all maturity* bond market indices were used. It should be also mentioned that even though the chosen currency for government bond indices was euros, the exception was made for several countries with the prerogative to benchmark government bond indices. These indices as the most qualitative and mostly used as references were the calculated in national currency for six countries: Czech Republic (Czech Koruna, CK), Denmark (Denmark Koruna, DK), Hungary (Hungarian Forint), Poland (Polish Zloty), Sweden (Swedish Koruna) and the UK (the UK Pound).

Finally, a remarkable limitation of the research is connected to the time horizon of data available. A 20 year research period was chosen in order to examine the situation during both relatively volatile and relatively more stable periods. Some of the countries did not have data available for the whole research period and in those cases data available was used for calculations. Only 17 out of 27 country's stock market indices and 12 out of 27 bond market indices have the data available for the whole sample period. It creates difficulties when evaluating the returns on those indices.

Due to the limitations of empirical research mentioned the results derived should be considered with carefulness and should not be treated as unquestionable statements. Despite of that, the data available is further used for calculations of returns on market indices and the evaluation of their characteristics.

III. EMPIRICAL RESULTS OF EVALUATION OF COMOVEMENTS BETWEEN FINANCIAL MARKETS IN EU COUNTRIES

3.1 Evaluation of Comovements between Financial Markets of the Same Asset Class in EU countries

The first stage of evaluation of comovements between stock and government bond markets in EU countries is implemented by analyzing the correlations between the market indices of the same asset class in different EU countries. The calculations for correlations were implemented by using *Statistical Package for the Social Sciences* (SPSS).

3.1.1. Comovements between Stock Markets in EU Countries

Evaluation of comovements between stock markets in EU countries is implemented by raising and confirming or rejecting the first hypothesis:

Hypothesis 1: The relationship between returns on main stock indices in the financial markets of EU countries is strong.

For approval or denial of this hypothesis, correlation coefficients between all EU's countries stock market indices were calculated. The hypothesis is approved if more than 50% of correlation coefficients obtained indicate medium or stronger correlation (are higher than 0.5). In addition to that, the coefficients calculated need to be statistically significant.

The correlation matrix between stock market indices in all EU countries in 1993-2013 is presented in Appendix 10. The whole data set includes 351 correlation coefficients (autocorrelations excluded). In order to evaluate a table with this huge set of data, the values were colored:

- Dark blue windows represent very strong positive correlation between the indices ($\rho \geq 0.7$);
- blue windows show medium correlation ($0.5 < \rho < 0.7$);
- white windows indicate weak correlation ($0.3 < \rho < 0.5$);
- grey windows represent very weak comovements between the stock markets with correlation coefficients being smaller than 0.3.

The overall distribution of the correlation coefficients between stock indices in EU countries can be seen in Figure 9.

It might be seen that the majority of correlations (more than 80% together) represents very weak and weak relationship between stock indices in EU countries. The rest of less than 20% of correlation coefficients indicate medium (14.53%) or strong (4.27%) relationship between the markets.

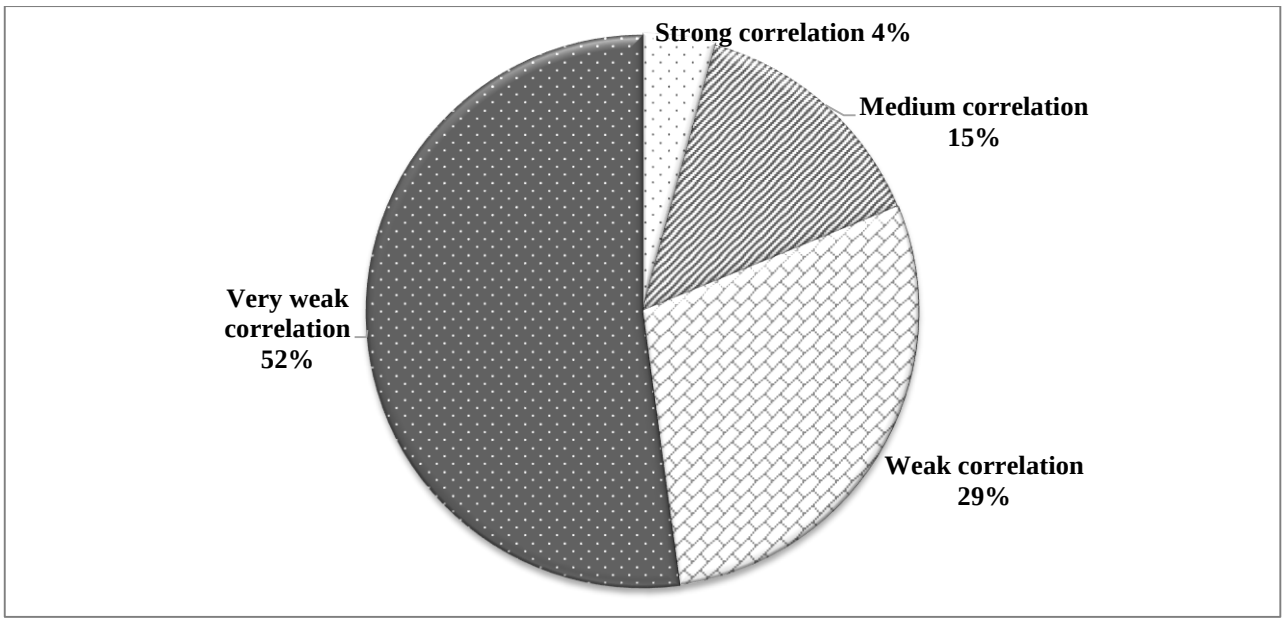

Figure 9. Distribution of correlation coefficients between stock indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

As concerning the statistical significance, the evaluation of *p-value* shows that all the medium and strong correlations between stock market indices of EU countries were statistically significant at 0.01 level. Despite of that, there were not enough medium-strong correlation coefficients obtained and the *Hypothesis 1* is rejected. The relationship between returns on main stock indices in all EU countries cannot be interpreted as strong.

Despite of that, it is beneficial to analyze the correlation matrix deeper. As the stock markets that are mostly related should be mentioned Austria, Belgium, France, Germany, Netherlands, Sweden and the UK. All these countries are major economies of EU with highly developed stock markets so this tendency is not surprising. This leads to the fact that in order to benefit from regional diversification an investor should not diversify between the stock markets mentioned due to very strong comovements between them. Despite of that, even though these markets move strongly together, their relationship with stock markets of other EU countries tend to mostly be not significant. For example, changes in returns of Belgium's stock index are very strongly correlated with changes of returns of Austria's, France's, Germany's, Netherlands's and the UK's stock market indices, have a weak correlation with Spain's stock market index. Correlation coefficients between returns on Belgium's and not mentioned EU countries' stock indices are very weak and insignificant. The same tendency can be concluded for the rest of the major equity markets mentioned.

On the contrary, all the correlation coefficients between movements of stock indices in Malta or Slovakia and indices of the rest of EU countries were very weak-weak, indicating almost independent movements of these markets from the rest of the Europe. Despite of that, when looking at Slovakia's column of correlations, it can be seen that the only two correlation coefficients that were

weak (white color) and statistically significant, were obtained for the comovements with stock indices in Hungary and Bulgaria. It indicates that even though the markets of Eastern European countries are tend to be more independent from the rest of EU markets, the indices of neighbor countries still move together. This represents the fact that these stock markets are seen as substitutes for each other by regionally diversifying investors, who might be investing in specific region and may not have a preference of whether to invest in Bulgaria or Hungary. Similarly, the only stock market that Cyprus index is highly correlated with is Greece. The same tendency exists in Baltic countries, with high correlations between Lithuanian and Estonian stock market indices. In addition, the regional investment strategy can also be confirmed by the correlation obtained between stock market indices of the North EU countries (Denmark, Finland, and Sweden). These stock markets weakly and insignificantly correlate with other strong major stock markets in EU. The North EU markets are very strongly related (again highlighting strong comovements in the same region) and also represent high significant correlations with such countries as Greece, Hungary, Ireland or Italy. Finally, most of the correlations between stock market indices in *PIIGS* countries (Portugal, Ireland, Italy, Greece and Spain) tend to be medium-high and significant with the exception of the Spain's. None of strong correlations between this country and all the rest of EU countries stock market indices were obtained indicating the independence of this stock market from stock markets in other EU economies.

The rejection of the first hypothesis should be an incentive for investors to diversify between EU stock markets. Despite of that, it can be clearly seen that there exist several regional tendencies for stock market comovements in separate regions. For the most efficient diversification between EU stock markets a *risk-averse* investor could choose diversification between Northern equity markets and Western EU equity markets, such as Belgium or Germany, providing smaller and safer returns, since the comovements between these markets were not significant during the research period. Similarly, a *risk-taking* investor could be recommended to diversify between Eastern or Central European countries and Western ones. In addition, it might be also beneficial to invest in Malta or Slovakia as being the least related stock markets with the rest of EU.

Since there exists a tendency of moving the investments from stock markets to bond markets those are usually assumed to be less risky, further analysis concentrates on comovements between government bond market indices in EU countries.

3.1.2. Comovements between Government Bond Markets in EU Countries

Similarly as the evaluation of comovements between EU stock markets, evaluation of comovements between government bond markets in EU countries is started by raising the second hypothesis:

Hypothesis 2: The relationship between returns on main government bond indices in the financial markets of EU countries is strong.

Similarly, the hypothesis is approved if more than 50% of correlation coefficients indicate medium and higher relationship ($\rho \geq 0.5$) and these coefficients are statistically significant. As it was already done for stock market indices, the correlation coefficients for government bond market indices were calculated and put into correlation matrix. The whole correlation matrix between government bond indices in EU countries is provided in Appendix 11 and Figure 10 represents the summary of these correlations.

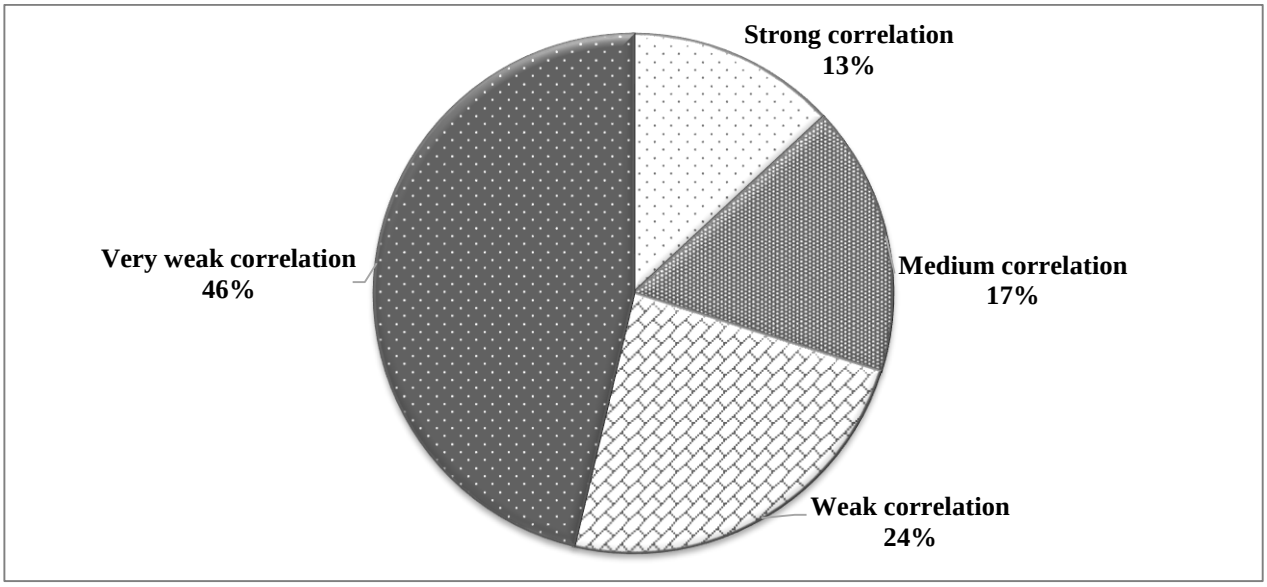

Figure 10. Distribution of correlation coefficients between government bond indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

It can be seen that the majority of correlation coefficients between government bond market indices in EU countries indicate very weak (46.31%) or weak (23.83%) but, differently from stock market indices, there are more medium and strong relationships between the markets. Correlation coefficients indicating medium and strong comovements between the government bond markets in EU countries together represent almost 30% of correlations. All these coefficients are statistically significant at 0.01 level. Despite of this fact, the majority of government bond market indices in EU countries have very weak or weak correlations. This leads to a rejection of *Hypothesis 2*: there exists a relationship between government bond market indices of EU countries, but it cannot be interpreted as strong for all the markets. This leaves space for regional diversification between government bond markets in EU countries.

A deeper analysis of the comovements between government bond indices in EU countries is implemented by using the same marking as for correlation matrix of stock indices. It can be seen from the first look at correlation matrix that there exists more medium-strong correlations between

government bond markets of EU countries than it was for stock markets. As the government bond markets with the most vivid comovements in between should be mentioned Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden and the UK. Differently than in stock markets, here the markets of North EU countries and Western EU countries are highly correlated in between. Some of the highest correlations obtained indicate almost linear relationship between the markets. For example, the correlation coefficient between government bond market indices in Austria and Germany during the research period was 0.937.

There is also a statistically significant high correlation between Spain's and Italy, Ireland government bond indices. When talking about new EU members, high degrees of correlations are obtained between government bond indices in Latvia, Lithuania and Romania. The correlation coefficients between these markets are statistically significant and indicate very strong, almost a linear relationship. All these countries only started calculating their government bond indices from January 2005, so the development of these indices might be similar due to this fact as well. As the countries having most independent government bond markets should be excluded Bulgaria, Cyprus and Greece with almost no medium or stronger relationships with government bond markets of other EU countries. Slovakia's index had a correlation of medium strength only with Slovenia's index, and Poland's index had the highest correlation with Czech Republic's and Hungarian government bond indices. A surprising finding is that Portugal's government bond index was mostly independent from other government bond indices with the exception of Ireland's index.

Even though most of correlation coefficients did not represent medium or stronger relationship, the majority of correlation coefficients were significant on either 0.05 level, implying that the relationship between the markets exists. These relationships do not cover all EU government bond markets, so regional diversification in the same asset class should still be beneficial. One of the possible explanations for the correlations between government bond markets being lower than anticipated could be the downgrade of countries' credit ratings in the recent years. Table provided in Appendix 12 represents the number of downgrades and upgrades of countries credit ratings by Fitch and S&P in from 2005 to 2012. It can be seen that during these years credit ratings for some EU countries left unchanged (Finland, Germany, Luxembourg, Netherlands, Denmark Sweden and the UK). On the contrary to that some of the countries experienced significant downgrades of their sovereign credit ratings (Cyprus, Greece, Ireland, Italy, Portugal, Slovenia, Spain, Hungary, Latvia, and Lithuania). Downgrading increased the costs of borrowing for governments, influencing the moves of bond indices. This is precisely the truth for Greece, Cyprus and Ireland, where sovereign credit ratings decreased the most during the period mentioned. Since the downgrading happened only in part of EU countries and not at the same time, the tendencies of movements of government bond indices could have changed and the correlations would have become lower.

The tendency of comovements of a smaller range than expected between government bond indices in EU countries is good news for regionally diversifying investor wanting to divest his investments between bonds issued by governments of different EU countries. It is possible to reduce the risk of the portfolio by investing in government bonds of advanced EU economies (Austria, Belgium) together with investments in bonds issued by governments of new EU countries (Bulgaria, Romania, Slovakia). Despite of that, from the perspective of a regionally diversifying investor it would be more difficult to gain from diversification effect when regionally diversifying between government bond markets in EU when compared to stock markets. Regardless of that, a risk-averse investor would still tend to diversify his investments between EU government bond markets rather that stock markets. A domestic investor, preferring investments in his home market or in other particular country, would choose diversification between different asset classes in the same country. In order to evaluate this kind of strategy, comovements of stock and government bond markets in EU countries are further evaluated.

3.2. Evaluation of Comovements between Stock and Government Bond Markets in EU countries

3.2.1. Comovements between Stock and Government Bond Markets in EU countries in the period of 1993-2013

After the analysis of the comovements in stock and government bond markets in EU countries separately, a more detailed analysis of relationship between stock and government bond indices in the same country is provided. A tendency of investors either choosing to invest in stock or in bond markets is changing due to increased accessibility of global stock and bond markets, reduction of trading costs and the integration of financial markets. Despite of that, there still exists a tendency of investors either choosing an international diversification, or the diversification between different asset classes in the same country. Some of the investors preferring home markets of markets of a certain foreign country tend to diversify between stocks and bonds in the same country. In order to check whether this strategy is beneficial and stock and government bond markets do not depend on each other strongly, the third hypothesis is formulated as follows:

Hypothesis 3: The relationship between returns on main stock and government bond indices in the financial markets of EU countries is strong.

The hypothesis is accepted if more than 50% of correlation coefficients calculated indicate medium or strong relationship between the markets.

The verification of this hypothesis is implemented in two steps. Firstly, on the same way as in separate stock and government bond markets of EU countries, the correlation coefficients between stock and government bond indices in the same EU country are calculated (Appendix 13). Secondly,

the volatility of correlations is estimated by calculating the rolling correlation windows (Appendix 14). The graphical representation of the correlations can be seen in Figure 11.

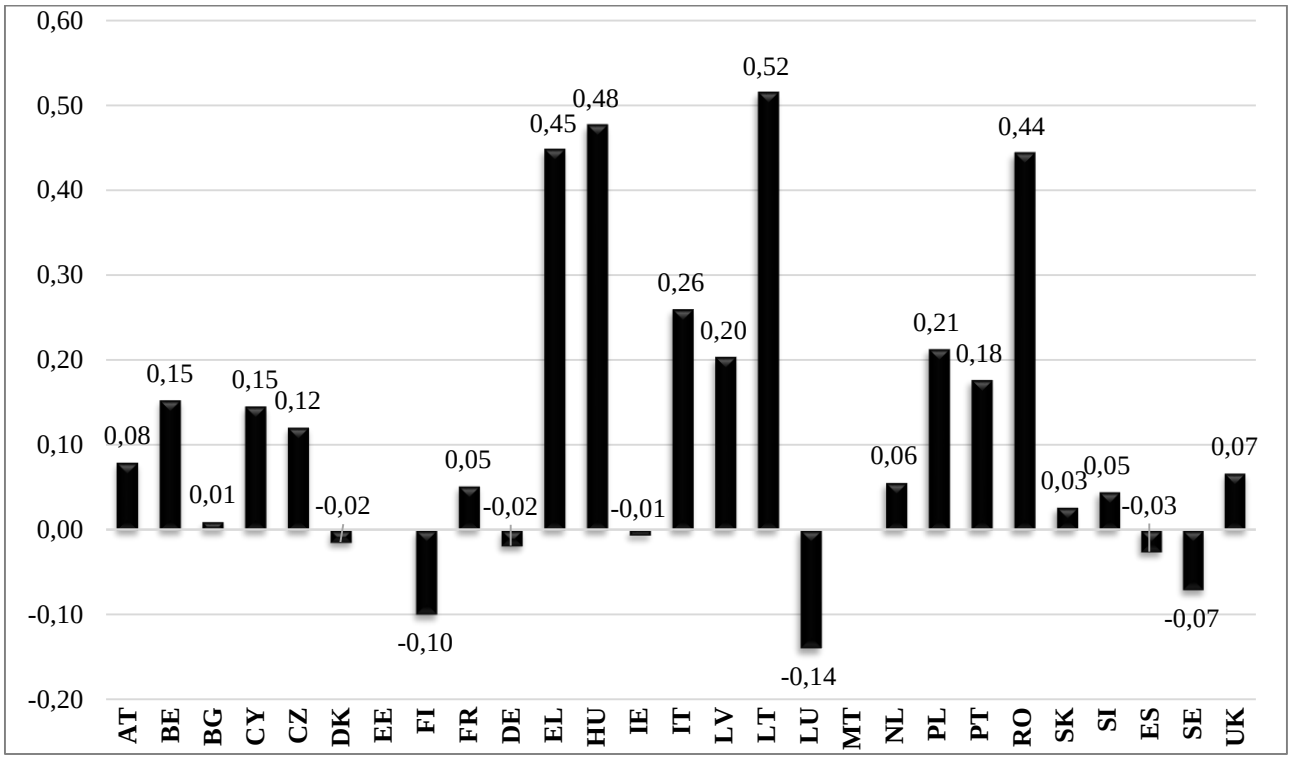

Figure 11. Correlation coefficients between stock and government bond indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

The results of comovements between stock and government bond markets of EU countries during the last 20 years are diverse. It can be seen that most of the correlation coefficients between indices of different asset classes in EU countries were quite small. First of all, indices in some countries demonstrate very small negative correlations between the markets. This happens in Denmark, Finland, Germany, Ireland, Luxembourg, Spain and Sweden. These correlations are not significant enough to be stated as leading to replacement of investments between different assets classes. This fact is also proven when looking at statistical significance of the correlations, evaluated by the *p-value*. All the *p-values* for correlations mentioned exceeded the 0.05 level of significance.

Positive, but very weak correlations between the stock and government bond markets ($\rho \leq 0.3$) were obtained in Austria, Belgium, Bulgaria, Cyprus, Czech Republic, France, Italy, Latvia, Netherlands, Poland, Portugal, Slovakia, Slovenia and UK. When looking at the statistical significance of the relationship between stock and government bond indices in the countries mentioned, it can be seen that only in Italy and Portugal the correlations obtained were significant at 0.05 level, indicating that for the rest of the countries the linear relationship between the financial markets during the research period was not meaningful enough. Correlation coefficients between stock and government bond market indices in Belgium, Latvia and Poland were significant at 0.05

level. In the rest of the countries mentioned the coefficients were not statistically significant. This indicates that the majority of stock and government bond indices do not move together and diversification between asset classes in a single country should be beneficial for the investor.

Only 4 countries (Greece, Hungary, Lithuania and Romania) have weak-medium correlations between stock and government bond indices. It is necessary to mention that all these correlation coefficients were significant at 0.05 level of significance. This means that stock and government bond markets in the countries mentioned were connected more than anticipated during the research period and this tendency requires for a deeper analysis. The only country from mentioned above with medium correlation between stock and government bond markets was Lithuania, where correlation between the markets was higher than 0.515. Stock and government bond markets in Lithuania tend to be more related than the financial markets in the rest of EU countries. These results might be caused by several reasons. Firstly, all the countries mentioned lacked the data of stock and government bond indices for the full sample period, so the shorter period might have influenced stronger correlations between stock and government bond markets in these countries. Secondly, for evaluation of comovements between financial markets in all these countries with the exception of Greece, all maturity government bond market indices were used. This type of indices might also influence stronger relationships between the markets. Finally, it is also possible that due to the fact that these countries are relatively new members of the EU, investors do not strongly differentiate between stock and government bond markets in these countries, assigning similar risk and expected return to both of the markets. As a result of that, stock and bond markets might commove stronger.

Even though the results obtained are heterogeneous and there exist significant correlations between stock and government bond indices in some EU countries, this is not a tendency. The majority of correlation coefficients between EU countries' stock and government bond indices are close to zero and indicate weak dependence between the markets. This leads to a conclusion that stock and bond markets of EU countries might not be influenced by the same factors or differently react to their changes. As already mentioned, only 4 countries' markets demonstrate significant comovements during the research period. This is not enough to accept the hypothesis and due to this fact the *Hypothesis 3* is rejected. The relationships between stock and government bond indices in EU countries are weak. Even though this fact should be beneficial for investor when choosing a diversification between asset classes strategy, this strategy might be not as beneficial as it is usually assumed to be. No significant negative correlation between market indices of different asset classes in 1993-2013 was recorded implying that in times of stock market fall government bond markets would not be the safe haven for investors. Due to that and no significant negative correlations existing between stocks and government bond markets of EU countries, there is no basis for approval of flight-to-quality between these markets in the last 20 year period. The fairness of this statement will be later

checked with the evaluation of comovements between stock and government bond markets in EU countries in the period of financial crisis in 2008-2013.

In addition to the analysis already implemented and in order to determine whether the correlations between stock and government bond indices in EU countries were stable or volatile during the research period, the rolling correlations between market indices in the same EU country were calculated. The minimum and maximum values of the rolling correlation windows together with the standard deviation of these correlations are graphically presented in Figure 12. The left axis represent minimum and maximum correlation coefficients while the right axis represents standard deviations of those coefficients. Summarized data is available in Appendix 13.

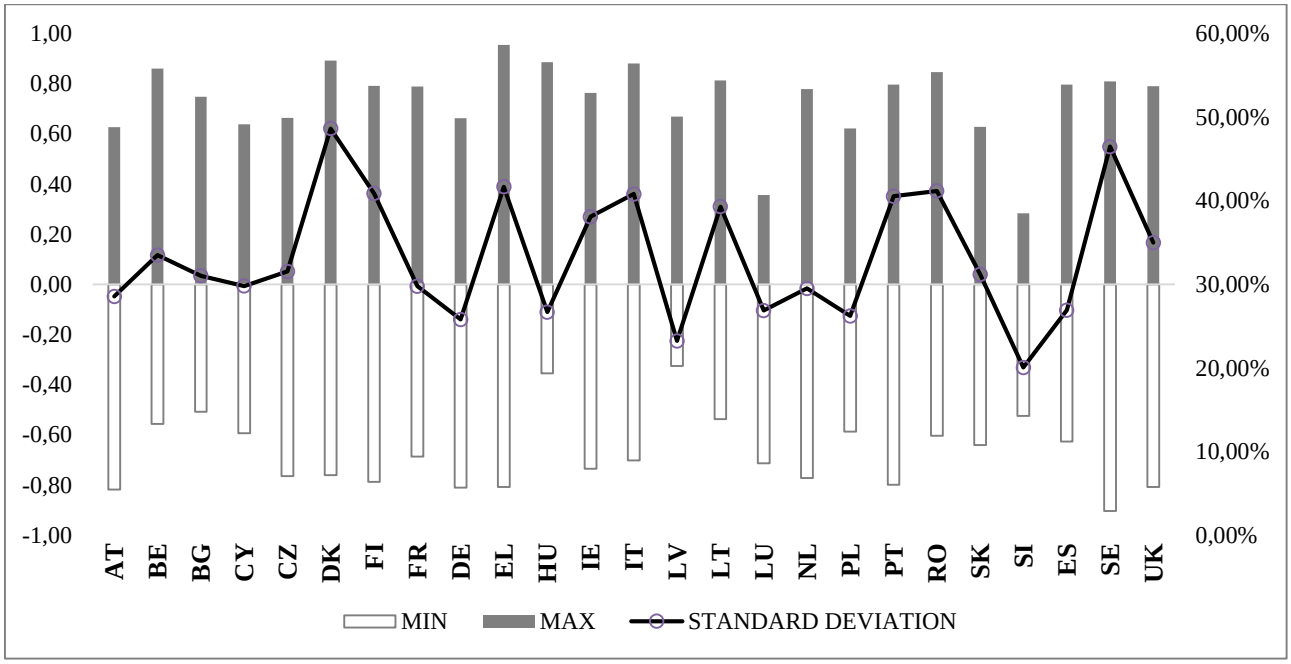

Figure 12. Characteristics of rolling correlation windows between stock and government bond indices in EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

It can be seen that the rolling correlations between stock and government bond indices in all the countries estimated were volatile, mostly varying from strong positive to strong negative values. This fact is very interesting because it shows that the relationship between stock and government bond markets in all EU countries is time-varying and cannot be interpreted as stable. Even in the most stable economies, such as Germany, at one period of time the correlations between stock and government bond indices were medium positive (ρ=0.66) while at another period of time this turned to totally opposite direction and the markets correlated strongly negatively (ρ=-0.81).

The latter correlation coefficient might have been assumed by an investor as indicating big diversification effect between stocks and government bonds and in times of financial stress in stock markets might have encouraged him to invest in government bonds triggering flight-to-quality phenomenon. Since this relationship was instantaneous, later, when stock and government bond

indices would have started moving together again, investor might have experienced significant losses. This tendency can be seen when looking at big standard deviations of rolling correlations. Mostly varying from 20% to 50% these deviations represent high volatility of the correlations between stock and government bond market indices in the same country. The most volatile rolling correlations with standard deviations exceeding 40% were derived between stock and government bond indices in Denmark, Sweden, Greece, Romania, Finland, Italy and Portugal. This is an interesting point because such countries as Denmark and Sweden with strong developed financial markets represented the least stable relationship between stock and government bond markets during the research period. On the contrary to that, the least volatile rolling correlations were derived in Slovenia's and Latvia's financial markets. This fact should not be interpreted as indicating a small volatility of the relationship between stock and government bond markets because both of these countries lack the data of market indices for the full period of research. With less data available the fluctuations of the relationship between the markets might not reflect the reality.

Coefficients of skewness and kurtosis were also calculated for the data of rolling correlations in order to confirm the conclusions previously made (Appendix 14). On the contrary to them, most of the coefficients of kurtosis on rolling correlations were negative (*platy kurtic*), indicating a lower, wider *peak*around the mean with *thinner tails*. This distribution is close to *Gaussian distribution* (usually referred to as the *normal distribution*). The parameter of skewness was not constant through all the sample, with both positive and negative skewnesses obtained, indicating that rolling correlations between stock and government bond market indices in EU's countries tended to vary to both sides of the mean. Countries with rolling correlations closest to symmetric distributions (with the mean close to the median and skewness close to zero) were Cyprus, Germany, Italy, Lithuania, the Netherlands, Poland, Slovakia and the UK.

Since it is very hard to reflect the changes in rolling correlations in 25 countries analyzed, the countries with all data available were chosen to demonstrate the fluctuations in correlations. They can be seen in Figure 13.

It should be remembered that rolling correlations with 12 months window estimate the changes in the dependence of market indices that have occurred during the last 12 months. Even though the countries reflected are major economies with developed strong financial markets, there is no consistency in rolling correlations between their stock and government bond indices during the research period. The fluctuations from strong positive to strong negative correlations are seen in most of the countries. When looking at the specific periods, it can be noticed that up to 2000's the correlations between stock and government bond indices tended to be strongly positive, with few exceptions in the UK. A huge jump in positive correlations between stock and government bond indices can be seen from January 2000. With the lagged estimations of rolling windows, this reflect

the changes during the previous 12 months, and actually shows the fact that after introduction of the euro (January 1999), Eurozone's stock and government bond markets became more closely related, at least for several years upcoming.

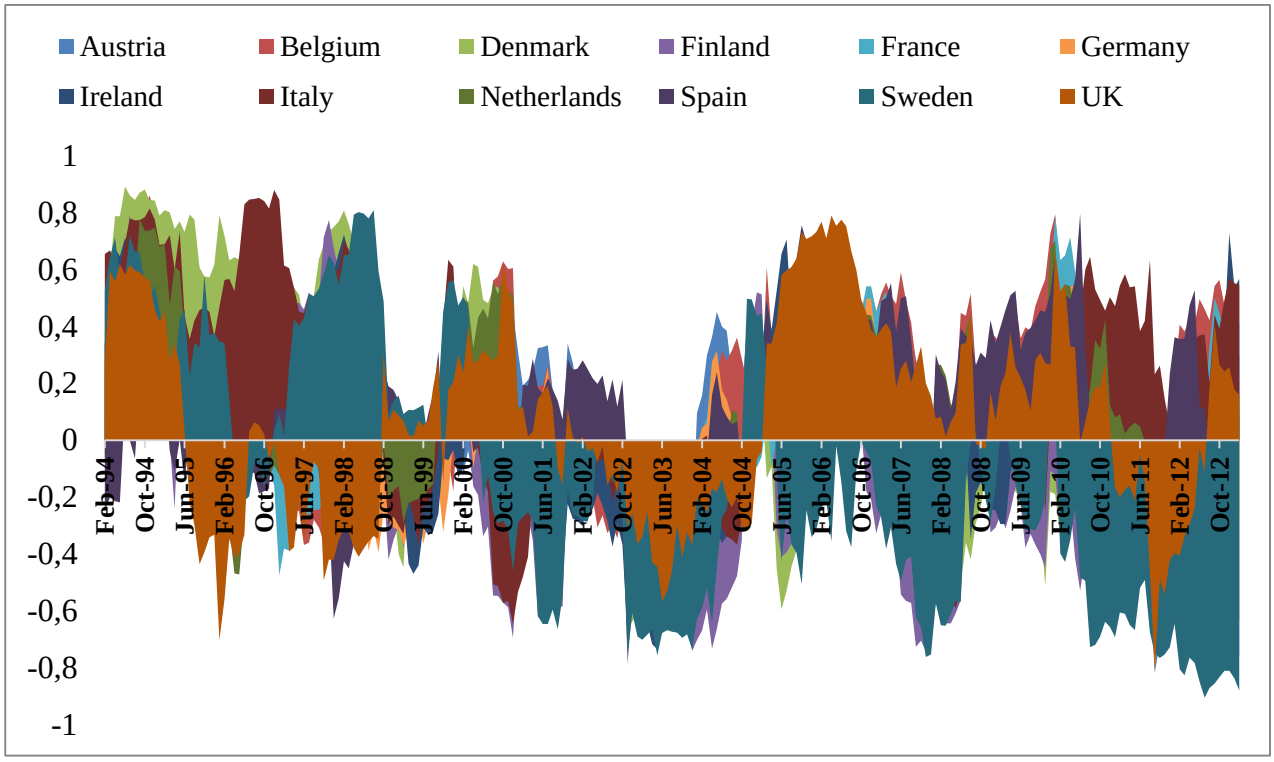

Figure 13. Rolling correlation coefficients between stock and government bond indices in chosen EU countries in 1993-2013

Source: author's calculations, based on *Thomson Reuters* data.

Later on, the so-called *internet bubble* crisis might have influenced short-term flight-to-quality in countries such as Sweden, Finland or the UK. For most of the time the relationship between stock and government bond indices in these countries tended to move to opposite directions.

There exists a phenomenon of Sweden – this country together with Finland was exposed to the highest negative correlation between stock and government bond indices. This is most clearly seen from the beginning of 2010 (so, reflecting the events from the beginning of 2009) and indicates that investors in EU chose to withdraw their money from stock markets and put it to the sovereign debt of North EU countries probably seeing them as stable and safe. On the contrary to that, the correlations between the stock and government bond market indices in Spain, Italy, France, and Belgium increased significantly from the beginning of 2009. The decrease of investor's confidence in these countries influenced both stock and government bond indices. Finally, it should be noticed that fluctuations in Germany's rolling correlations are mostly not seen in the graph, indicating that during all the period Germany's stock and government bond market's had a rather stable relation.

The analysis of comovements between stock and government bond markets in EU countries in 1993-2013 has led to a conclusion that there is a tendency of them to depend on each other, but it

cannot be interpreted as strong. In addition, the dependencies between stock and government bond markets in EU countries can be named rather volatile and not stable during the full research period. Various authors have concluded that the relationships between different asset classes tend to change in times of financial turmoil in the markets. In order to check the fairness of this statement comovements between the stock and government bond markets in EU countries in the period from 2008, referred to as financial crisis, are analyzed further.

3.2.2. Comovements between Stock and Government Bond Markets in EU Countries in the Period of Financial Crisis

The evaluation of comovements between stock and government bond market indices in EU countries in the period of January 2008-February 2013 is implemented by calculating correlation coefficients between the markets for this shorter period and evaluating their statistical significance. The data of the correlations obtained together with the *p-values* can be seen in Appendix 15. Figure 14 graphically represents the correlation coefficients between stock and government bond indices in 25 EU countries from January 2008 to February 2013.

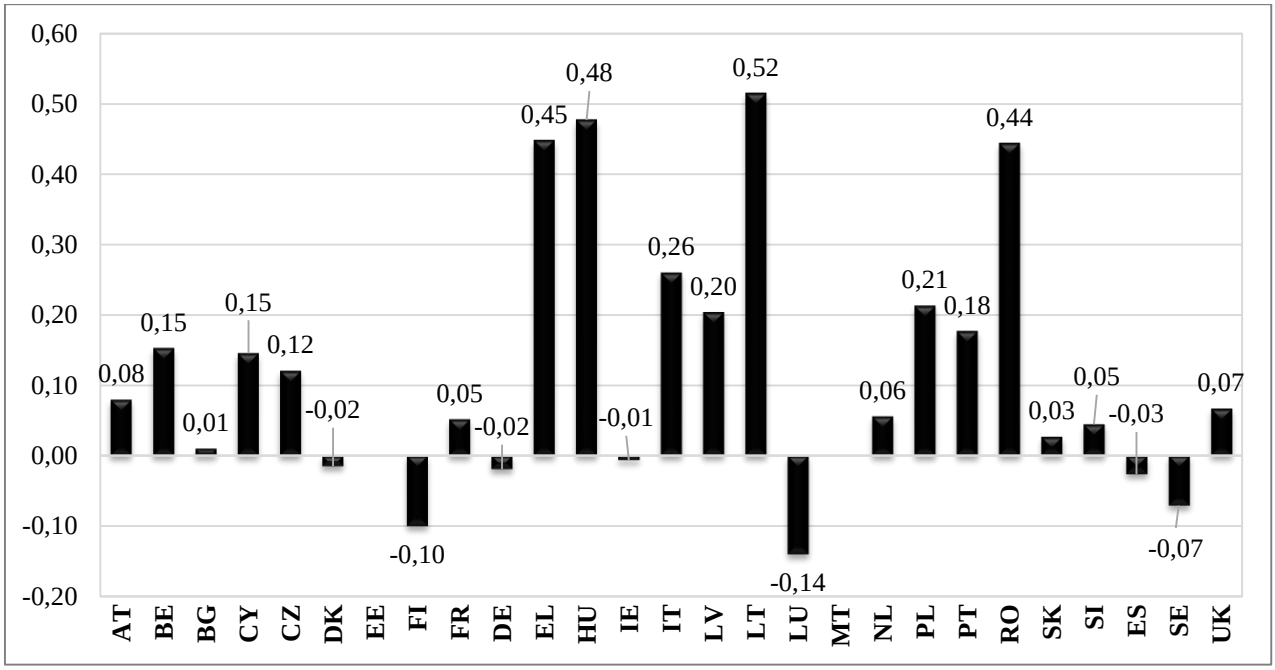

Figure 14. Correlation coefficients between stock and government bond indices in EU countries in 2008-2013

Source: author's calculations, based on *Thomson Reuters* data.

There exists a wide distribution of correlation coefficients between financial markets of EU countries during this shorter sample period. Most of EU countries experienced very weak and statistically insignificant correlations between stock and government bond markets with correlation coefficients being smaller than 0.3 and either positive (Belgium, Cyprus, Czech Republic, France, Ireland, Italy, Latvia, Luxembourg, Netherlands, Slovenia, Spain and the UK) or negative (Austria,

Bulgaria, Germany, Slovakia). None of these coefficients were statistically significant when evaluated with the *p-value* with the exception of Belgium. Even though the correlation between stock and government bond indices in this country was positive and very weak, it appeared to be significant at 0.05 level. Despite of that it can be still stated that even at times of financial crisis the financial markets of different asset classes in the countries mentioned tended to move independently from each other. This fact should be beneficial for investors diversifying between the asset classes in the same country.

Traditional financial theorists claim that in times of financial stress stock and government bond indices should move into different directions due to a willingness of investors to reduce the risk on the price of the return. On the contrary to that the data of several EU countries stock and government bond indices indicate an opposite relation. It can be seen that there are several countries where correlations between stock and government bond market indices were positive and strong enough for indication of comovements between the markets. These results were obtained in Greece, Hungary, Lithuania, Poland, Portugal and Romania. The highest correlation coefficients were calculated in Hungary, Greece, Lithuania and Romania, indicating medium relationship between the markets during the research period. All these correlation coefficients were significant at 0.05 level. To support these correlations the arguments already mentioned can be used: not full data sample, later integration (for Lithuania, Poland and Romania) and serious country's financial problems in recent years (Greece, Portugal). The results show that diversification between assets classes in these countries would be nothing but damaging due to stock and government bond market comovements to the same direction in times of financial stress.

Despite of the common tendency of positive comovements of financial markets in these countries, every single country should be analyzed separately. Changes in Greece's and Lithuania's stock and government bond indices were chosen for comparison. As the country suffering from extreme financial difficulties Greece lost investors' confidence and this is reflected in both stock and government bond markets of the country (Figure 15).

Stock and government bond indices in Lithuania during the research period were significantly positively related but differently from Greece's situation they experienced a decrease in value up to August 2009 and later started increasing. The volatility of Lithuanian stock and government bond market indices is similar with the gap between values of the indices being relatively stable. This fact contradicts with financial theory, stating that stock market indices should be much more volatile due to reflection of higher risk undertaken when compared with government bond market and could be named *the phenomenon of the financial crisis*. Despite of that, both stock and government bond markets in Lithuania are not very liquid and developed, the economic situation in Lithuania was much more stable in times of financial crisis when compared to Greece.

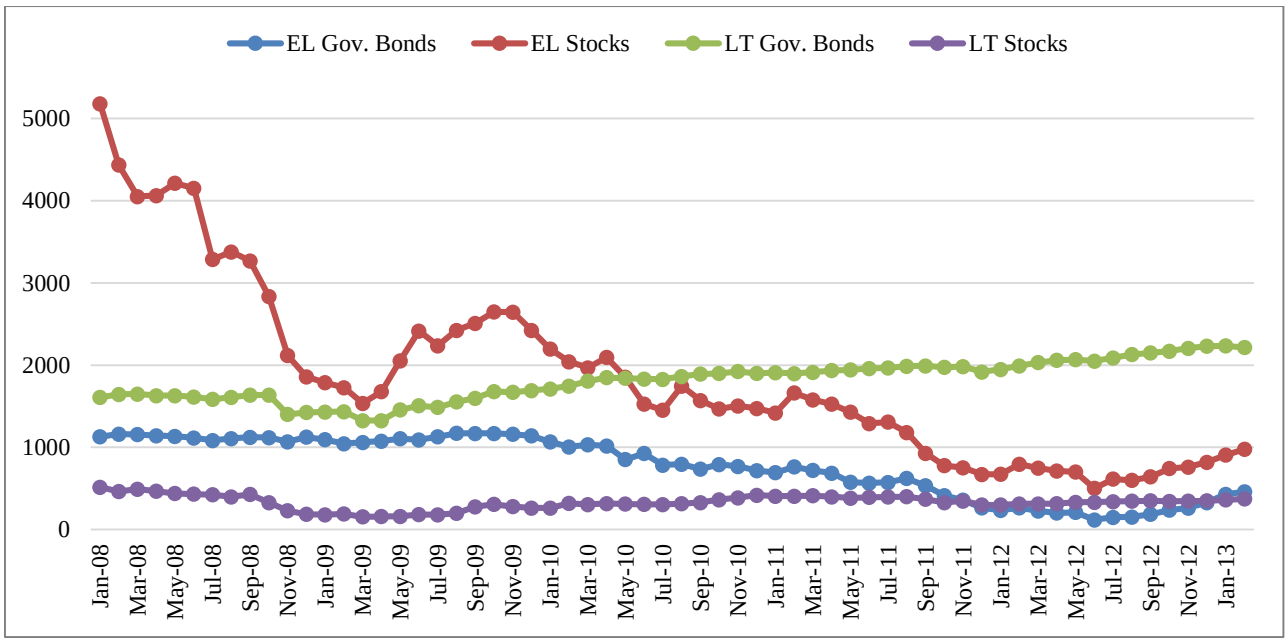

Figure 15. Dynamics of stock and government bond indices in Greece and Lithuania in 2008-2013

Source: *Thomson Reuters* data.

This leads to investors' confidence being similar in stock and government bond markets and resulting in significant comovements between the markets. The situation of Greece is opposite. A huge drop in stock market index of this country can be seen from the beginning of the research period. This tendency lasted up to mid-2009. For the next further months the value of stock index in this country raised, but in December 2009 started dropping again. This represents the downgrading of the country by three major rating agencies. Even though fluctuations of Greece's government bond index are much smaller, the same reaction to major events can be also obtained from the changes of this index. It proves that both equity and government bond markets tend to similarly react to extreme financial difficulties in a separate country as overall confidence of the country decreases and investments are withdrawn.

Finally, there also exist three countries where correlation coefficients between stock and government bond markets were negative during the period of 2008-2013. These are Scandinavian countries: Denmark (-0.395), Finland (-0.399) and Sweden (-0.456). All these coefficients are significant at 0.05 level and indicate inverse relationship between stock and government bond markets in the time period of the last 5 years. The financial markets of these countries are usually seen as stable and as a tendency are chosen by more risk-averse investors. A conclusion might be derived that during the times of high changeability and uncertainty in global economy even investors in stock markets mentioned tended to change their preferences to government bonds in order to avoid high risk and to assure a safe return. In other words, it can be stated that Denmark's, Finland's and Sweden's financial markets experienced flight-to-quality phenomenon. For deeper analysis the values

of stock and government bond indices of these countries during the research period are plotted in Figure 16.

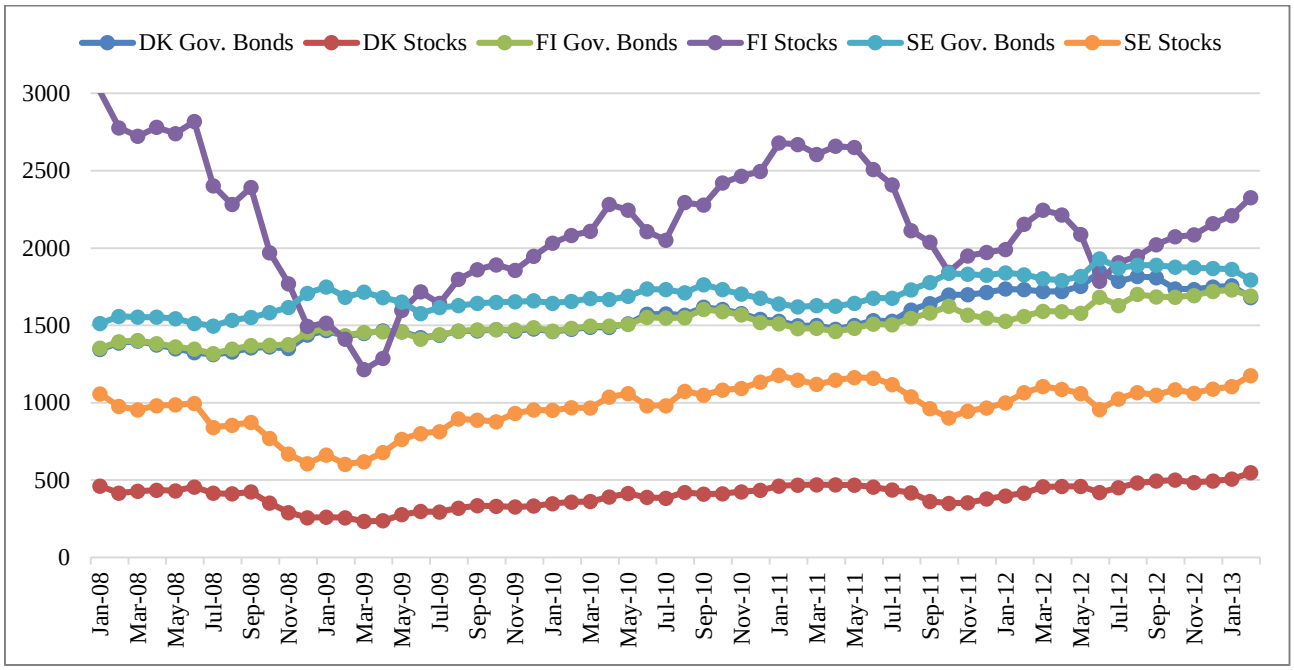

Figure 16. Dynamics of stock and government bond indices in Denmark, Finland and Sweden in 2008-2013

Source: *Thomson Reuters* data.

The most evident difference in movement of stocks and government bond indices can be seen in Finland. At the time of an extremely significant decrease of stock market index up to April 2009, the value of Finland's 10 year government bond index was increasing almost all the time. From April 2009 to July 2010 both stock and government bond indices in Finland were increasing but later on they again started moving to opposite directions with the peak of the stock market index being the lowest point of government's bond index.

Similar results could be also indicated with the changes of stock and government bond indices in Denmark and Sweden but due to smaller changes in absolute values themselves these changes are harder to see in the graph.

After separate evaluation of correlation coefficients between stock and government bond indices in EU countries during the full research period and the period of financial crisis, it is necessary to evaluate the changes obtained. In order to check the fairness of the statement of increasing correlations in financial markets in times of financial stress the fourth hypothesis was raised:

Hypothesis 4: The relationship between returns on main stock and government bond indices in the financial markets of EU countries became stronger in the period of financial crisis from 2008.

This hypothesis is confirmed if correlations between stock and government bond markets increased in more than 50% of EU countries when reducing the calculation period to 2008-2013. Correlation coefficients obtained in both periods are plotted in Figure 17.

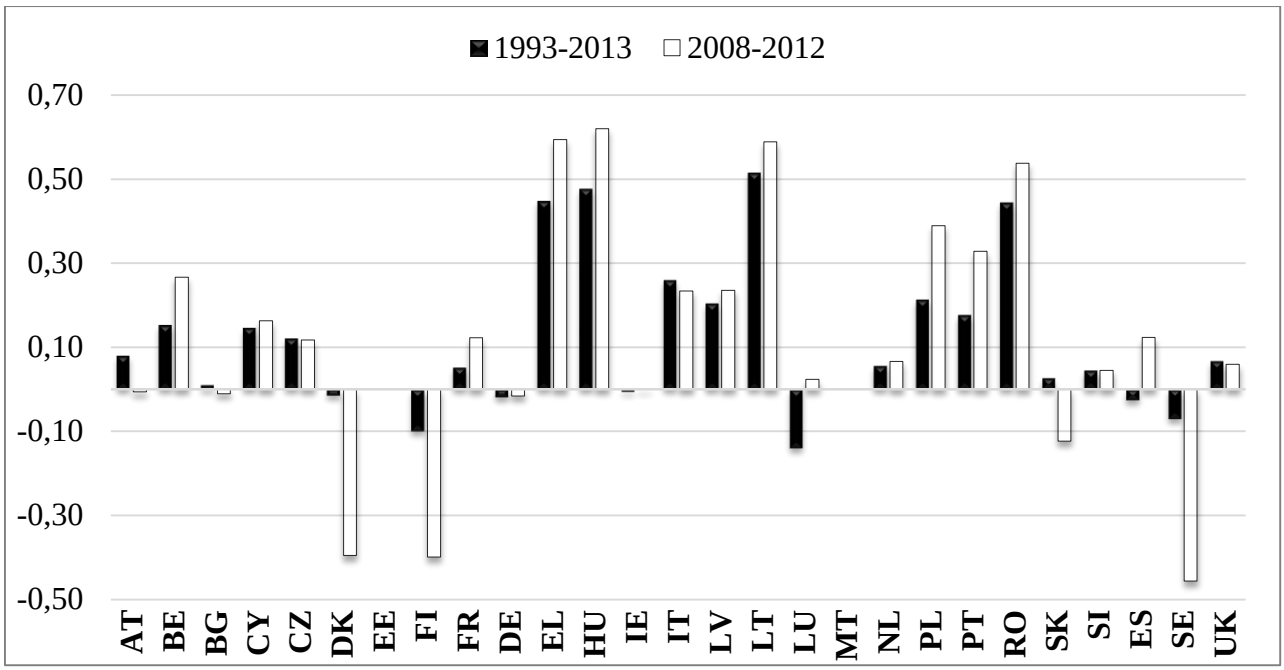

Figure 17. Correlation coefficients between stock and government bond indices in EU countries in 1993-2013 and 2008-2013

Source: author's calculations, based on *Thomson Reuters* data.

It can be seen that in most of the countries correlations between stock and government bond indices increased significantly to both positive and negative directions in the period from 2008. It was also noticed that most of the correlations didn't change their direction with the exception of Austria, Bulgaria, Ireland, Luxembourg, Slovakia and Spain. These changes were very small and left the correlations insignificant. In the countries with weak-medium correlations between stock and government bond indices the significance of the coefficients also increased. The most significant increase in correlations between stock and government bond markets was obtained in the countries already mentioned: Denmark, Finland and Sweden. The exceptions with decrease in correlation coefficients when shortening the research period were Austria, Czech Republic, Germany, Italy, Luxembourg and the UK. Having in mind that correlations in Slovenia didn't change because of the data of its government bond indices only available from 2008, this leaves financial markets of 19 EU countries with stronger comovements between markets in time of financial crisis from 2008. Due to this fact the *Hypothesis 4* is accepted. The strength of the relationship between stock and government bond markets in EU countries increased in the period of financial crisis from 2008. This result has a dual impact on investor's decision-making. From one point of view, this is beneficial for allocation of investments in the countries such as Denmark or Finland because this leads investor to benefit by dividing the risks between different asset classes. On the contrary to that, this fact is harmful for investors who diversified in countries such as Greece or Hungary. Due to significant comovements between stock and government bond indices in these markets the diversification affect might disappear leaving investor with losses in times of declining financial markets.

3.3. Research Generalization and Comparison with Other Researches

The veracity of four hypotheses raised for this research was verified by the implementation of the analysis of stocks and government bond markets in EU countries. The summary of the hypotheses tested and the results obtained can be seen in Table 10.

Table 10

Summary of the hypotheses tested in the research

No.	Hypothesis	Acceptance	Argumentation
1	The relationship between returns on main stock indices in the financial markets of EU countries is strong	**Rejected**	Most of the correlation coefficients indicated very weak (52%) or weak (29%) relationship between stock markets in EU countries in 1993-2013.
2	The relationship between returns on main government bond indices in the financial markets of EU countries is strong	**Rejected**	Most of the correlation coefficients indicated very weak (46%) or weak (24%) relationship between stock markets in EU countries in 1993-2013. Despite of that, there were stronger and significant correlation coefficients between government bond markets than between stock markets of EU countries (correspondingly 4% and 13%).
3	The relationship between returns on main stock and government bond indices in the financial markets of EU countries is weak	**Rejected**	Medium correlation coefficient between stock and government bond markets in 1993-2013 was only obtained in Lithuania (0.52). Relatively high correlations were derived between financial markets in Greece (0.45), Hungary (0.48) and Romania (0.44). The rest of the relationships between stock and government bond markets of EU countries were small and insignificant.
4	The relationship between returns on main stock and government bond indices in the financial markets of EU countries intensified in the period of European sovereign debt crisis from 2008	**Accepted**	The comovements between stock and government bond markets in the period of 2008-2013 strengthened in 19 out of 25 EU countries. Financial markets had significant medium correlations in Lithuania (0.59), Greece (0.59), Hungary (0.62) and Romania (0.54). There appeared to be significant negative correlations between financial markets of Sweden (-0.46), Finland (-0.40) and Denmark (-0.40) in 2008-2013, indicating possible flight-to-quality in Scandinavian countries.

Source: compiled by the author.

It can be seen that out of 4 hypotheses raised for the research 3 were rejected and only 1 was confirmed. The first two rejected hypotheses were aiming to evaluate the relationships inside stock and government bond markets in EU countries during a sample period of 20 years, the third and the fourth ones were raised for determination of strength of the comovements between stock and government bond indices with different periods used for the analysis.

The *Hypothesis 1* raised was oriented to test the significance of relationships between stock markets in EU countries. Due to the fact that majority of the correlations between stock markets in EU countries were very weak or weak, this hypothesis was rejected. Despite of that, it should be highlighted, that some countries depending to particular regions have strongly connected stock markets with statistically significant positive correlations, so diversification between these markets would not reduce the risk of the investor. The rejection of the first hypothesis coincides with the results of B. Solnik (2000), stating that correlations still leave space for risk spread. Similarly, the correlations between stock markets were not stable over time, as D. M. Rey (2000), F. Rezayat and

B. F. Yavas, M. I. Gallali and B. Kilani (2010) have already noticed. On the other hand, rejection of the hypothesis raised contradicts with I. Moldovan and C. Medrega (2011) and Lee (2012) who state that correlations of stock markets significantly increase in times of financial crisis. This was not noticed as a tendency in all EU markets investigated in this research.

Even though there exists a relationship between government bond indices of EU countries, it cannot be interpreted as being strong for the majority of the markets. This leads to rejection of the *Hypothesis 2* with the conclusion that international portfolio diversification between government bond markets should be beneficial. Again, this strategy should be implemented taking into account that about 30% of EU government bond markets strongly commove together with medium or high statistically significant correlations. The rejection of the second hypothesis lies in the middle between the results obtained by other authors: it partly confirms the conclusions of C. Ciner (2007) and M. Brennan, A. Kobor and V. Rustaman (2011) about direct relationship between government bond markets in different countries. On the other hand, the results partly with the results obtained by J. Yang (2005), who states that no long-run relationship between major government bond markets exists. Significant and strong correlations were obtained between some of the EU government bond markets, but this could not be stated to be a tendency. Despite of that, analysis of government bond markets in EU countries showed higher and more significant between these markets when compared with stock markets during a long run.

The test of the *Hypothesis 3* lead to a conclusion that only 4 countries' stock and government bond markets demonstrated significant comovements during the research period. This was not enough to accept the hypothesis and due to this fact the *Hypothesis 3* was rejected. The relationships between stock and government bond market indices in EU countries are weaker than they were expected to be. Even though this fact should be beneficial for diversifying between the asset classes investor, this strategy might be not as beneficial as it is usually assumed to be. No significant negative correlation between market indices of different asset classes during the research period was obtained indicating that in times of stock market fall government bond markets would not save the investments by hedging the risk. These results contradict with the ones obtained by J. Yang, Y. Zhou and Z. Wang (2009), stating that bonds help to hedge against stock market risk. In addition, there is no basis for overall approval of flight-to-quality between all EU financial markets. Finally, the evaluation of comovements between stock and government bond markets resulted in determination of large variations in intra-asset correlations as L. Li (2002), J. T. Scruggs and P. Glabadanidis (2003), L. Cappiello, R. F. Engle and K. Sheppard (2006) had already noticed. L. Li (2002), M. Andersson, E. Krylova and S. Vahamaa (2004), S. D'Addonna and A. Kind (2006) related the changes in these correlations with the inflation.

The only accepted hypothesis was *Hypothesis 4*, stating that relationships between stock and government bond markets in EU countries increased in the period of the financial crisis starting from 2008. This tendency was valid for 19 of 25 EU countries. The approval of the hypothesis allies with the fact that comovements between stock and government bond markets tend to increase due to globalization and financial stress, as D. G. Baur (2009) has noticed. The fact that the increase in the correlations between stock and government bond indices in financial crisis was not very high also partly coincides with the assertion of T. Viitanen (2011) that stock-bond relations tend to be stable under extreme market conditions. The author only analyzed the biggest financial markets for which this research also provides quite stable relationship in time of financial stress. In addition, the exclusion of possible flight-to-quality in Scandinavian countries in the period of 2008-2013 coincides with the results of D. G. Baur and B. M. Lucey (2006; 2008) confirming flight-to-quality only in several EU countries. Finally, the results of financial markets' comovements in the period of financial crisis contradict with the research of L. Baele, G. Bekaert and K. Inghbrecht (2009) stating that correlations between stock and government bond indices in most of EU countries decreased with the time.

The research can be further developed towards different directions. Firstly, due to the fact, that majority of researches by previous authors were implemented in the US, it would be beneficial to include stock and government bond market indices of this country to the research. Secondly, the scope of the research didn't allow focusing on particular countries, but it would be useful to concentrate on several countries with strongest comovements inside stock and government bond markets and provide a more detailed estimation for these changes. Thirdly, the research could also include corporate bond indices and analyze how movements of them are different from the movements of government bond indices. Fourthly, correlation coefficient does not reflect the causality of the relationship, so it is not possible to estimate either stock markets influence government bond markets or vice versa. This could be avoided by choosing other method for estimation of the comovements between financial markets of EU countries. Nevertheless the scope of the research limits the choice of methods used. Finally, the analysis needs more focus on the investigation of the reasons for the differences in the relationship between financial markets in EU countries.

CONCLUSIONS AND RECOMMENDATIONS

1. Relationship between financial markets is a highly investigated topic. Most of the studies in the field conclude correlations between stock and bond markets increasing due to globalization. Despite of that, majority of the researches concentrate on stock markets. In addition, most of studies of comovements between financial markets are implemented in major economies with a lack of studies in smaller/emerging markets. This makes the results hard to apply to a larger scope. In recent years a point of attention is drawn to EU's government bond markets as a reflection of country's financial situation in financial crisis. Results of previous researches of relationship between financial markets indicate significant volatile comovements between them mainly determined by inflation or its expectations. Multiple authors have proven existing comovements between stock and government bond markets in major EU countries, not generalizing it as a tendency. In was also proven in several markets that in times of financial crisis comovements between financial markets strengthen and negative correlations appear indicating flight-to-quality from stocks to government bonds. Despite of that, this is mainly concluded for Eurozone countries' financial markets leaving the rest of EU members behind. The aim of this research was to fill this gap by providing insights of comovements between stock and government bond markets in all EU countries together with recommendations for portfolio diversification.

2. Analysis of comovements of financial markets in EU countries, implemented by using statistical estimations of logarithmic returns on stock and government bond indices based on data of 52 indices from 27 countries in the period of 1993-2013, showed that stock indices were much more volatile than bond market indices. In addition, stock market returns strongly exceeded government bond returns during the research period. This coincides with financial theory, stating that stock markets should generate higher returns for investors as a compensation for extra risk taken.

3. Evaluation of comovements between financial markets of EU countries was implemented by using Pearson's correlation coefficient for determination of the relationship. Logarithmic returns on market indices were used for calculations of these coefficients between stock, government bond and stock-government bond markets of EU countries during the period of 1993-2012. The final stage of the research included the estimation of correlations in the period of 2008-2013, commonly referred to as financial crisis. Having in mind that high correlations don't necessary reflect significant relationship between variables, statistical significance of coefficients was evaluated by calculating *p-value* and testing Fisher's null hypothesis. For evaluation of comovements between financial markets in EU countries 4 hypotheses were raised, approved or rejected based on the strength and statistical significance of correlation coefficients obtained.

4. Analysis of correlation coefficients between stock markets of EU countries showed majority of correlations being very weak or weak. The *Hypothesis 1* concerning strong correlations

between EU stock markets was rejected. Despite of that, stock markets in Austria, Belgium, France, Germany, Netherlands, Sweden and the UK were strongly correlated leaving not much space for diversification. Comovements of these markets with other stock markets were mostly insignificant. Contrarily, stock markets of Slovakia and Slovenia could be used for international diversification as their indices tend to move independently from the rest of EU's. A point of particular interest was the proven existence of regional correlation: stock markets of Nordic, Eastern European, Baltic, Eagan countries were stronger connected with each other than with the rest of the markets. Investors with regional preferences might see these markets as substitutes. Finally, most of the correlations between stock indices in *PIIGS* countries were strong and significant with exception of Spain where stock market moved rather independently during the period of research.

5. Analysis of comovements between EU's government bond markets has shown a higher scope of medium-strong correlations between these markets than between stock markets. One of the possible explanations can be a common monetary policy between EU countries. Despite of that, *Hypothesis 2*, stating that the relationship between returns on government bond indices in EU countries is strong, rejected as a result of not enough strong correlations derived. Government bond markets with the most vivid comovements in between were Austria, Belgium, Denmark, Finland, France, Germany, the Netherlands, Sweden and the UK, mostly having almost linear comovements in between. As in stock markets, regional comovements were obtained. Statistically significant high correlations were between government bond markets in Spain and Italy, Ireland; Latvia, Lithuania and Romania; Slovenia and Slovakia; Poland and Czech Republic, Hungary. Contrarily, government bond markets of Bulgaria, Cyprus, Greece and Portugal had almost no medium-strong correlations with other markets and could be called almost independent. This is useful for investors when hedging their risk. Overall the relationship between government bond markets in EU cannot be interpreted as strong, so diversification in the same asset class should still be beneficial. From the perspective of regionally diversifying investor it would be more difficult to gain from diversification effect in EU's government bond markets than in stock markets, but risk-averse investor would still tend to diversify between government bond markets. On the other hand, domestic investor, preferring particular country, would choose to diversify between asset classes.

6. Diverse results were obtained from analysis of comovements between stock and government bond markets in EU countries. Most of correlation coefficients were rather small, not significant leading to rejection of *Hypothesis 3:* the relationship between stock and government bond indices in EU countries was rather weak. The exception exists in financial markets of Greece, Hungary, Lithuania and Romania with weak-medium significant correlations. This might be caused by lack of data, different indices used or these countries being new members of EU (with the exception of Greece). The results indicate financial markets in these countries being more related than

in the rest of EU countries, not suitable for diversification between asset classes. Even though the rejection of the third hypothesis shows the possibility of diversification between asset classes in most of EU countries, this strategy might not be as beneficial as it's assumed to be. No significant negative correlation between market indices of different asset classes in 1993-2013 was recorded implying that in times of stock market fall government bond markets aren't the safe haven. As a result there is no basis for approval of flight-to-quality between these markets in the last 20 years. In addition, rolling correlations revealed volatile dependencies between stock and government bond markets of EU countries varying from strongly positive to strongly negative values during the research period. There was a tendency of correlations becoming more negative with the ongoing financial crisis that was further estimated by analyzing changes of comovements in 2008-2013.

7. Analysis of comovements between stock and government bond markets of EU countries from 2008 resulted in increase of correlation coefficients in 19 of 25 countries analyzed. Due to that, *Hypothesis 4* was accepted indicating strengthened comovements between stock and government bond markets in times of financial stress. Despite of that, most of the correlations were positive. This isn't beneficial for investors: due to significant comovements between markets in countries as Greece or Hungary the diversification effect may disappear when most needed. As the exceptions should be mentioned Denmark, Finland and Sweden. Significant negative correlations obtained in these countries indicate the existence of flight-to-quality and lead to benefits from inter-asset diversification in Scandinavian countries in times of financial stress. Comovements between stock and government bonds in other EU countries tend to be not strong during the period of financial crisis, not allowing to confirm a wide scope flight-to-quality between the markets.

8. The results of the research are significant because they provide a possibility to compare comovements inside stock and government bond markets and between these markets in EU countries. This is beneficial for investor, searching for diversification opportunities in EU countries. As the final outcome of the research, only 1 of 4 hypotheses raised was accepted indicating financial markets of EU countries being less related than expected to be and leaving place for diversification benefits. These results partly comply with the results of previous studies in the topic, mostly confirming the tendencies for biggest EU financial markets. Despite of that, the results should be interpreted with caution due to limitations of the research, in particular diversity and lack of data for some countries. The research can be further implemented towards different directions: inclusion of the US, concentration on countries with strongest comovements between financial markets and provision of detailed estimation of these changes; inclusion of corporate bond indices; choice of other method for estimating comovements between financial markets. Finally, the analysis needs more focus on investigation of the reasons for the differences in the relationship between financial markets in EU countries.

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APPENDICES

Appendix 1

The Vocabulary of Terms

Asset allocation	An investment strategy that aims to balance risk and reward by apportioning a portfolio's assets according to an individual's goals, risk tolerance and investment horizon (http://www.investopedia.com)
Bear markets	A market condition in which the prices of securities are falling, and widespread pessimism causes the negative sentiment to be self-sustaining (http://www.investopedia.com)
Benchmark	Standard, or a set of standards, used as a point of reference for evaluating performance or level of quality (http://www.businessdictionary.com)
Blue chip	A nationally recognized, well-established and financially sound company. Blue chips generally sell high-quality, widely accepted products and services (http://www.investopedia.com)
Bull markets	A financial market of a group of securities in which prices are rising or are expected to rise. The term "bull market" is most often used to refer to the stock market, but can be applied to anything that is traded, such as bonds, currencies and commodities (http://www.investopedia.com)
Collateral	In lending agreements, collateral is a borrower's pledge of specific property to a lender, to secure repayment of a loan (http://dictionary.reference.com)
Comovements	The correlated or similar movements of two or more entities (Baur, 2003)
Contagion	The likelihood that significant economic changes in one country will spread to other countries. Contagion can refer to the spread of either economic booms or economic crises throughout a geographic region (http://www.investopedia.com)
Convergence	A situation in which people or things gradually become the same or very similar (Macmillan Dictionary, 2012)
Correlation coefficient (Pearson)	Measure of the strength and direction of the linear statistical relationship between two variables (Kunigėlytė, Laškovas and Markelevičius, 1986).
Covariance	A measure of association between two variables enabling to summarize this association with a single number (http://www.lse.ac.uk)
Credit Rating	An opinion on the relative ability of an entity to meet financial commitments, such as interest, preferred dividends, repayment of principal, insurance claims or counterparty obligations, used by investors as indications of the likelihood of receiving the money owed to them in accordance with the terms on which they invested (*Fitch* Ratings, 2013)
Decoupling	The occurrence of returns on asset classes diverging from their expected or normal pattern of correlation (http://www.investopedia.com)
Downside risk	An estimation of a security's potential to suffer a decline in value if the market conditions change, or the amount of loss that could be sustained as a result of the decline. Downside risk explains a "worst case" scenario for an investment, or how much the investor stands to lose (http://www.investopedia.com)

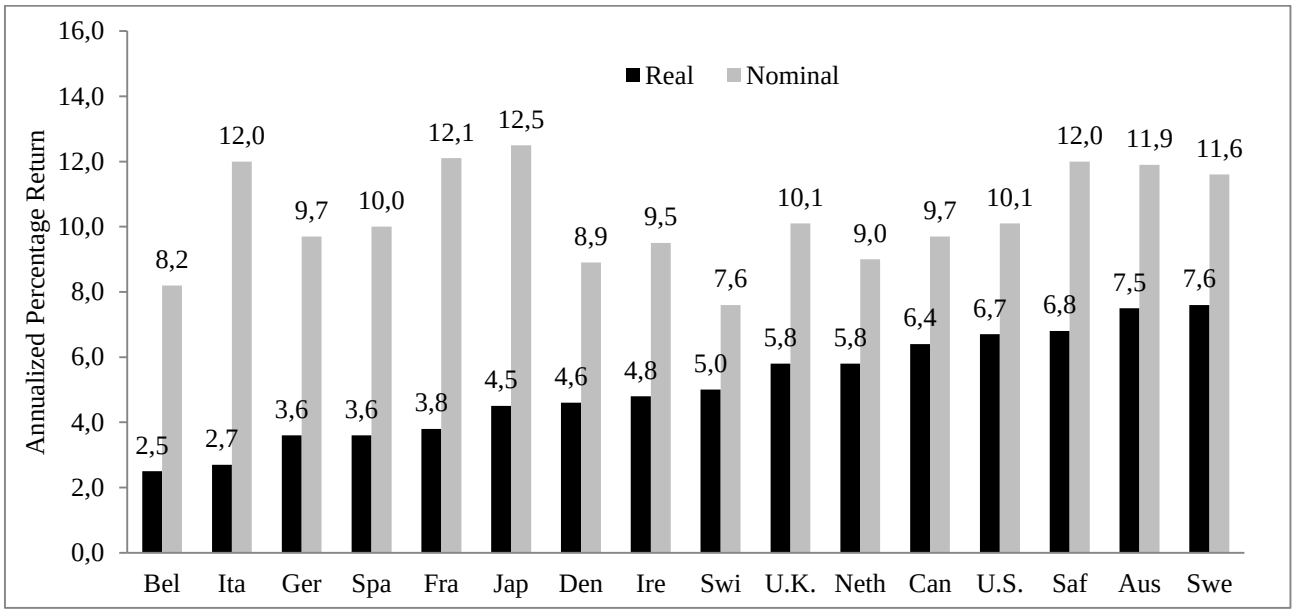
European Central Bank (ECB)	The central bank that has been responsible for monetary policy in the euro area since 1999. Located in Frankfurt, Germany with main mission to maintain price stability and the euro's value in the 15 European countries comprising the euro area (http://business.yourdictionary.com)
European Monetary Union (EMU)	The process by which the economic and monetary policies of the EU Member States are harmonized, culminating in the introduction of a single currency, the euro (http://www.eurofound.europa.eu)
Ex-ante	A term that refers to future events, such as future returns or prospects of a company. Using ex-ante analysis helps to give an idea of future movements in price or the future impact of a newly implemented policy (http://www.investopedia.com)
Ex-post	Ex-post is the opposite of ex-ante, which means "before the event" (http://www.investopedia.com)
Financial crisis	A situation in which the value of financial institutions or assets drops rapidly, often associated with a panic or a run on the banks, in which investors sell off assets or withdraw money from savings accounts with the expectation that the value of those assets will drop if they remain at a financial institution (http://www.investopedia.com)
Fisher's null hypothesis	The proposition that implies no effect or no relationship between phenomena. The null hypothesis is popular because it can be tested and found to be false, which then implies there is a relationship between the observed data (http://mathworld.wolfram.com)
Flight-*from*-quality	The action of investors moving their capital to riskier activities in order to gain bigger return (Baur and Lucey, 2006)
Flight-*to*-quality	The action of investors moving their capital away from riskier investments to the safest possible, usually caused by uncertainty in financial markets (Baur and Lucey, 2006)
GARCH model	Generalized Auto Regressive Conditional Heteroskedasticity (GARCH) process used by financial professionals in several arenas including trading, investing, hedging and dealing and including 3 steps: estimation of a best-fitting autoregressive model, computation of autocorrelations of the error term and testing for significance (http://www.investopedia.com)
Gaussian (Normal) distribution	Bell-shaped symmetrical frequency distribution curve, a characteristic of many economic phenomenon where two or more variables have direct relationship and high predictability (low variation). Extremely-large and extremely-small values are rare and most-frequent values are clustered around the mean (http://www.businessdictionary.com)
Government bonds	Debt instruments issued by national government and promising to pay a certain amount (the face value) on a certain date, as well as periodic interest payments (http://www.investopedia.com)
Inflation	The rate at which the general level of prices for goods and services is rising, and, subsequently, purchasing power is falling (http://inflationdata.com)
Interconnectedness	A state of being connected reciprocally (http://www.wordnik.com)

Hedging risk	The taking of an offsetting position in related assets so as to profit from relative price movements (http://business.yourdictionary.com)
International diversification	An allocation of investments in a portfolio of international securities in order to achieve broader equity exposure to many foreign markets while spreading the risks associated with investing in any one foreign market (http://www.investorwords.com)
Investment strategy	Systematic plan to allocate investable assets among investment choices such as bonds, certificates of deposit, commodities, real estate, stocks (http://www.businessdictionary.com)
Lead-lag relationship	The situation where one (leading) variable is correlated with the values of another (lagging) variable at later times (http://www.investopedia.com)
Level of significance	The probability of a false rejection of the null hypothesis in a statistical test (http://www.thefreedictionary.com)
Kurtosis	Measure of the peakedness or flatness of a curve based on the moments of the distribution (http://www.springerreference.com)
Leptokurtic distribution	A term defining a situation where statistical value of distribution is positive with higher peaks around the mean compared to normal distributions and thick tails on both sides. These peaks result from the data being highly concentrated around the mean, due to lower variations within observations (http://www.investopedia.com)
Market index	The average of prices of chosen group of securities (http://www.nasdaqomxbaltic.com)
Mesokurtic distribution	A term defining a situation where the kurtosis of a distribution is similar to the kurtosis of a normally distributed data set. The kurtosis coefficient of a normal distribution is 3 (http://www.investopedia.com)
Market capitalization	Total value of the issued shares of a publicly traded company, equal to the share price multiplied by the number of shares outstanding (http://financial-dictionary.thefreedictionary.com)
Monetary policy	Monetary policy is the process by which the monetary authority of a country controls the supply of money, often targeting a rate of interest for the purpose of promoting economic growth and stability (http://www.bankofcanada.ca)
Moving average	An arithmetic average over a rolling window of consecutive data points taken from a time series. A useful tool for financial analysis (Alexander, 1998)
Peakedness	The excess frequency at the center of the distribution (http://www.unesco.org)
Portfolio diversification	Spreading the available funds over a wider selection (portfolio) of types of investment, such as commodities, real estate, securities (http://www.investorwords.com)
p-value	The level of marginal significance within a statistical hypothesis test, representing the probability of the occurrence of a given event (http://www.investopedia.com)
Regional diversification	A portfolio strategy designed to reduce exposure to risk by combining a variety of investments in a specific region
Security	A fungible, negotiable financial instrument that represents some type of financial value. (http://www.investopedia.com)

Skewness	Measure of the asymmetry of the based on the notion of the moment of the distribution (http://www.springerreference.com)
Sovereign bonds	A debt security issued by a national government within a given country and denominated in a foreign currency (http://www.investopedia.com)
Spillover effect	Externalities of economic activity or processes that affect those who are not directly involved. (http://www.allbusiness.com)
Standard deviation	A statistical term that measures the amount of variability or dispersion around an average; a measure of volatility (http://stockcharts.com)
Sub-prime crisis	A financial crisis that arose in the mortgage market after a sharp increase in mortgage foreclosures, mainly subprime, collapsed numerous mortgage lenders and hedge funds (http://www.investopedia.com)
Rate of return	The gain or loss on an investment over a specified period, expressed as a percentage increase over the initial investment cost (http://www.investopedia.com)
Risk-aversion	The subjective tendency of investors to avoid risky investments (isites.harvard.edu/fs)
Risk-taking	The tendency of engaging in risky investments have the potential to provide a big loss, yet at the same time provide the opportunity for a very positive outcome (oxforddictionaries.com)
Reaching-for-yield	Investors' propensity to buy high yield assets without regard for risk (Becker and Ivashina, 2013)
Tail risk	A form of portfolio risk that arises when the possibility that an investment will move more than three standard deviations from the mean is greater than what is shown by a normal distribution (http://www.investopedia.com)
Turmoil	Chaos, confusion or disturbance(http://dictionary.reference.com)
Yield spread	The difference between yields on differing debt instruments, calculated by deducting the yield of one instrument from another. The higher the yield spread, the greater the difference between the yields offered by each instrument (http://www.investopedia.com)

Appendix 2

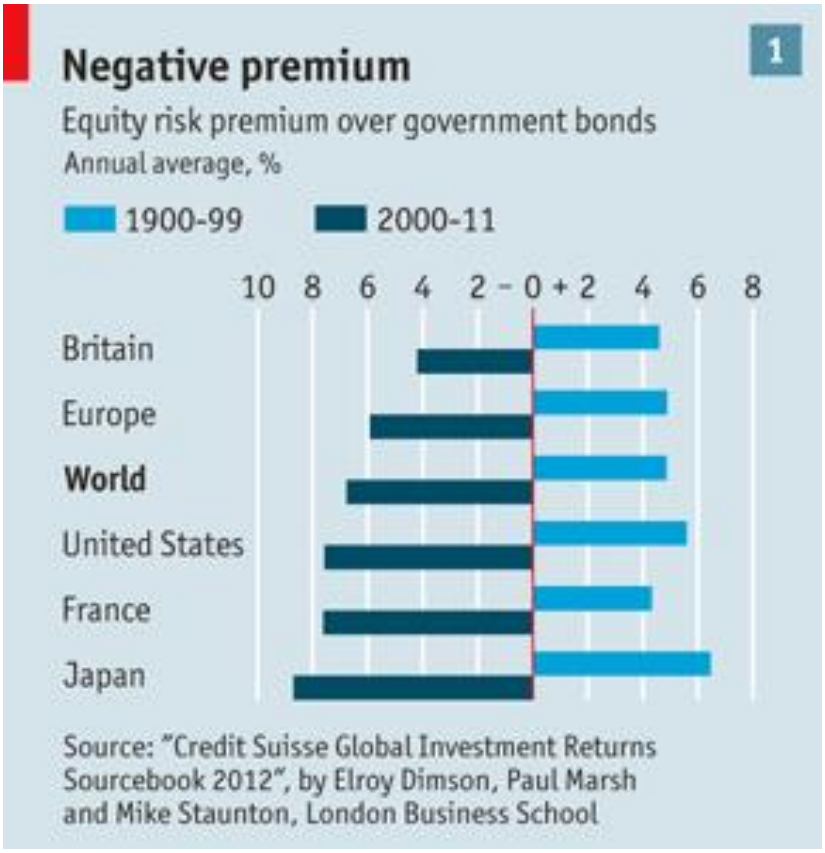
Nominal and real equity returns around the world in 1900-2000



Source: compiled by the author, based on E. Dimson, P. Marsh and M. Staunton (2002)

Appendix 3

Equity risk premium over government bonds in 1900-2011



Secondary source: The Economist (http://www.economist.com/node/21550273)

Appendix 4

Pre-crisis data from World Bank with 25 countries with largest equity capitalization

	Billions of U.S. Dollars						Percent of the World		Growth (%)
Name	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2002**	**2007**	**2002-2007**
WORLD	**20024**	**27085**	**31701**	**35476**	**43045**	**48332**	**100,0%**	**100,0%**	**141,4%**
U.S.	9172	12023	13345	13934	15606	15921	45,8%	32,9%	73,6%
JAPAN	2076	2934	3486	4420	4505	4280	10,4%	8,9%	106,2%
U.K.	1796	2363	2730	2925	3692	3723	9,0%	7,7%	107,3%
FRANCE	911	1238	1436	1667	2313	2572	4,5%	5,3%	182,3%
GERMANY	633	990	1117	1219	1599	2020	3,2%	4,2%	219,1%
CANADA	488	750	960	1206	1339	1669	2,4%	3,5%	242,0%
HONG KONG	402	593	706	778	1120	1669	2,0%	3,5%	315,2%
SWITZERLAND	543	710	812	921	1193	1251	2,7%	2,6%	130,4%
AUSTRALIA	360	540	641	721	933	1188	1,8%	2,5%	230,0%
ITALY	463	600	778	786	1020	1070	2,3%	2,2%	131,1%
SPAIN	312	479	635	651	926	1017	1,6%	2,1%	226,0%
KOREA	200	265	356	549	655	865	1,0%	1,8%	332,5%
NETHERLANDS	437	539	612	543	725	777	2,2%	1,6%	77,8%
SWEDEN	170	267	343	366	510	499	0,8%	1,0%	193,5%
SINGAPORE	92	133	154	183	314	412	0,5%	0,9%	347,8%
BELGIUM	127	171	269	270	335	359	0,6%	0,7%	182,7%
FINLAND	133	161	174	198	252	341	0,7%	0,7%	156,4%
NORWAY	65	92	137	193	267	340	0,3%	0,7%	423,1%
DENMARK	72	110	143	163	201	231	0,4%	0,5%	220,8%
GREECE	52	83	105	124	174	228	0,3%	0,5%	338,5%
AUSTRIA	31	54	87	133	173	203	0,2%	0,4%	554,8%
ISRAEL	33	54	67	85	109	156	0,2%	0,3%	372,7%
PORTUGAL	46	62	74	71	106	136	0,2%	0,3%	195,7%
IRELAND	53	76	106	111	157	136	0,3%	0,3%	156,6%
NEW ZEALAND	21	31	40	39	41	44	0,1%	0,1%	109,5%
OTHERS	1336	1767	2388	3220	4780	7225	6,7%	14,9%	440,8%
EUROPEAN COUNTRIES	5844	7995	9558	10341	13643	14903	29,2%	30,8%	155,0%
EUROPEAN UNION COUNTRIES	5236	7193	8609	9227	12183	13312	26,1%	27,5%	154,2%

Source: Datastream.

Appendix 5

World's largest stock exchanges by market capitalization in 2012

	Exchange	USD bn end-2012	USD bn end-2011	% change in USD	% change in local currency
1	NYSE Euronext (US)	14 086	11 796	19.4%	19.4%
2	NASDAQ OMX (US)	4 582	3 845	19.2%	19.2%
3	Tokyo Stock Exchange Group	3 479	3 325	4.6%	17.6%
4	London Stock Exchange Group	3 397	3 266	4.0%	2.4%
5	NYSE Euronext (Europe)	2 832	2 447	15.8%	14.0%
6	Hong Kong Exchanges	2 832	2 258	25.4%	25.2%
7	Shanghai SE	2 547	2 357	8.1%	7.0%
8	TMX Group	2 059	1 912	7.7%	5.3%
9	Deutsche Börse	1 486	1 185	25.5%	23.6%
10	Australian SE	1 387	1 198	15.7%	14.3%

Source: http://brazilianbubble.com/ranks-here-are-the-worlds-largest-stock-exchanges-by-market-cap/

Appendix 6

Codes of EU countries

Country	Code	Country	Code	Country	Code
Austria	AT	Germany	DE	Netherlands	NL
Belgium	BE	Greece	EL	Poland	PL
Bulgaria	BG	Hungary	HU	Portugal	PT
Cyprus	CY	Ireland	IE	Romania	RO
Czech Republic	CZ	Italy	IT	Slovakia	SK
Denmark	DK	Latvia	LV	Slovenia	SI
Estonia	EE	Lithuania	LT	Spain	ES
Finland	FI	Luxembourg	LU	Sweden	SE
France	FR	Malta	MT	United Kingdom	UK

Source: http://epp.eurostat.ec.europa.eu/statistics_explained/index.php/Glossary:Country_codes

Appendix 7

A sample of returns calculated for stock and government bond indices in EU countries

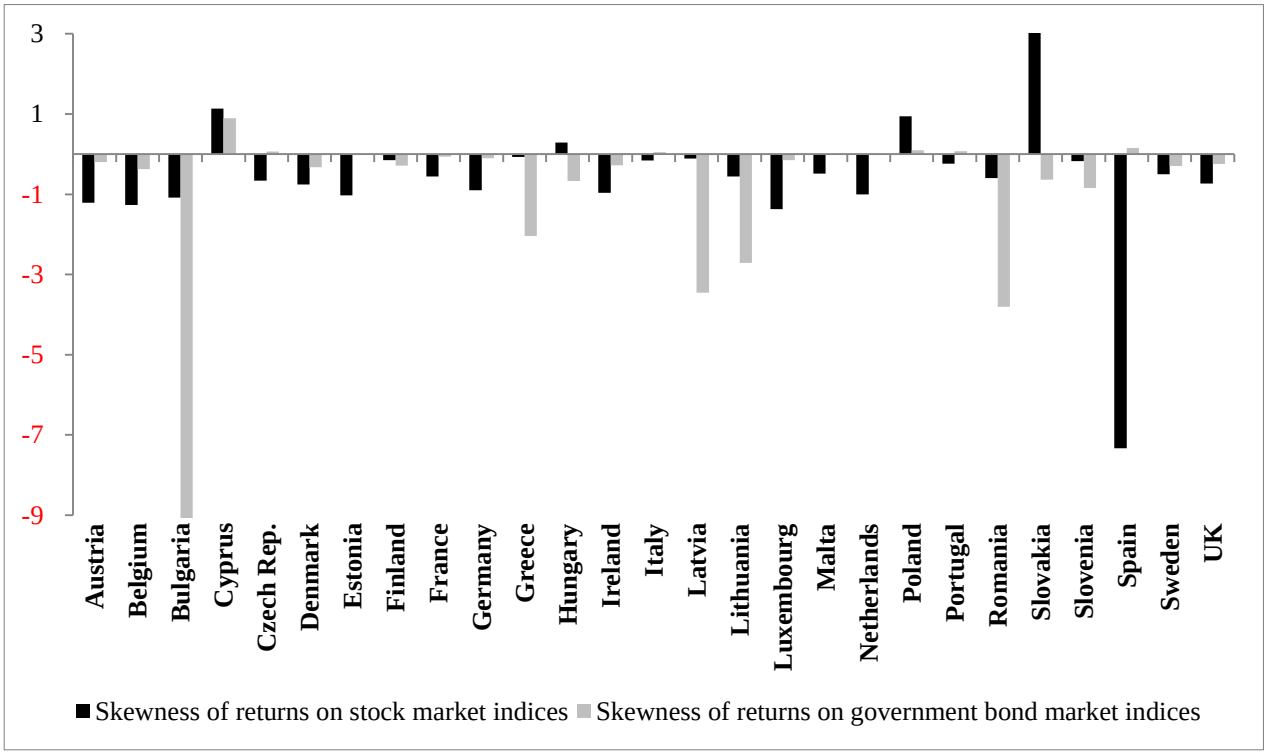
Start	1993-08-02	Start	1993-05-02	Start	1993-01-02	Start	1993,01,02
End	2013-08-02	End	2013-07-02	End	2013-01-02	End	2013,01,02
DENMARK		**FINLAND**		**FRANCE**		**GERMANY**	
Name	DK BENCHMARK	Name	FN BENCHMARK	Name	FR BENCHMARK	Name	BD BENCHMARK
Code	S08908	Code	S08980	Code	S08914	Code	S08726
CURRENCY	DK	CURRENCY	E	CURRENCY	E	CURRENCY	E
1993-08-02		1993-05-02		1993-01-02		1993-01-02	
1993-01-03	1,35%	1993-01-03	1,84%	1993-01-03	3,13%	1993-01-03	2,96%
1993-01-04	3,31%	1993-01-04	-0,31%	1993-01-04	1,76%	1993-01-04	-0,70%
1993-03-05	1,78%	1993-03-05	2,03%	1993-03-05	0,32%	1993-03-05	-0,63%
1993-01-06	1,27%	1993-01-06	1,25%	1993-01-06	-0,67%	1993-01-06	-0,73%
1993-01-07	4,83%	1993-02-07	5,18%	1993-01-07	3,52%	1993-01-07	1,69%
1993-02-08	0,42%	1993-03-08	3,32%	1993-02-08	2,00%	1993-02-08	0,88%
1993-01-09	0,83%	1993-01-09	1,10%	1993-01-09	2,26%	1993-01-09	2,11%
1993-01-10	-0,18%	1993-04-10	-1,54%	1993-01-10	0,57%	1993-01-10	0,35%
1993-01-11	1,63%	1993-01-11	3,45%	1993-01-11	0,62%	1993-01-11	1,39%
1993-01-12	-0,09%	1993-02-12	2,03%	1993-01-12	-0,30%	1993-01-12	0,03%
1994-03-01	1,96%	1994-04-01	3,18%	1994-03-01	2,68%	1994-03-01	1,84%
1994-01-02	0,48%	1994-02-02	3,39%	1994-01-02	-0,62%	1994-01-02	-0,64%
1994-01-03	-3,42%	1994-01-03	-5,02%	1994-01-03	-4,46%	1994-01-03	-3,38%
1994-01-04	-2,76%	1994-01-04	-6,20%	1994-01-04	-1,13%	1994-01-04	-0,36%
1994-03-05	-2,07%	1994-02-05	-2,59%	1994-02-05	-2,68%	1994-02-05	-1,27%
1994-01-06	-7,18%	1994-01-06	-6,18%	1994-01-06	-4,63%	1994-01-06	-3,34%
1994-01-07	-1,82%	1994-01-07	-2,80%	1994-01-07	-0,44%	1994-01-07	-0,18%
1994-01-08	3,82%	1994-01-08	-1,47%	1994-01-08	2,01%	1994-01-08	1,44%
1994-02-09	-5,57%	1994-01-09	-3,00%	1994-01-09	-4,03%	1994-01-09	-3,00%
1994-03-10	-1,54%	1994-04-10	3,03%	1994-03-10	-2,21%	1994-03-10	-2,10%
1994-01-11	0,40%	1994-01-11	-1,29%	1994-01-11	-0,28%	1994-01-11	-0,17%
1994-01-12	2,66%	1994-01-12	-0,44%	1994-01-12	2,80%	1994-01-12	1,88%
1995-02-01	-3,52%	1995-02-01	1,05%	1995-02-01	-2,63%	1995-02-01	-2,29%
1995-01-02	1,49%	1995-01-02	-0,77%	1995-01-02	1,44%	1995-01-02	1,52%
1995-01-03	0,74%	1995-01-03	1,80%	1995-03-03	0,03%	1995-01-03	0,77%
1995-03-04	-0,57%	1995-03-04	0,30%	1995-03-04	1,70%	1995-03-04	1,00%
1995-01-05	1,91%	1995-01-05	5,53%	1995-01-05	0,10%	1995-01-05	0,98%
1995-01-06	3,51%	1995-02-06	3,07%	1995-01-06	2,93%	1995-01-06	2,11%
1995-03-07	-2,95%	1995-03-07	-2,22%	1995-03-07	-1,76%	1995-03-07	-2,28%
1995-01-08	2,25%	1995-01-08	1,36%	1995-02-08	2,03%	1995-01-08	1,26%
1995-01-09	1,56%	1995-01-09	3,17%	1995-01-09	-0,04%	1995-01-09	0,42%
1995-02-10	0,74%	1995-02-10	0,93%	1995-03-10	-0,54%	1995-02-10	0,83%
1995-01-11	0,74%	1995-01-11	0,76%	1995-01-11	0,93%	1995-01-11	0,78%
1995-01-12	3,16%	1995-01-12	2,72%	1995-01-12	2,42%	1995-01-12	2,13%
1996-01-01	1,27%	1996-01-01	0,68%	1996-01-01	1,89%	1996-01-01	0,69%
1996-01-02	0,94%	1996-01-02	-0,09%	1996-02-02	1,50%	1996-01-02	0,73%

Note: all the data and calculations are in the possession of the author and might be provided with a request.

Source: author's calculations, based on *Thomson Reuters* data.

Appendix 8

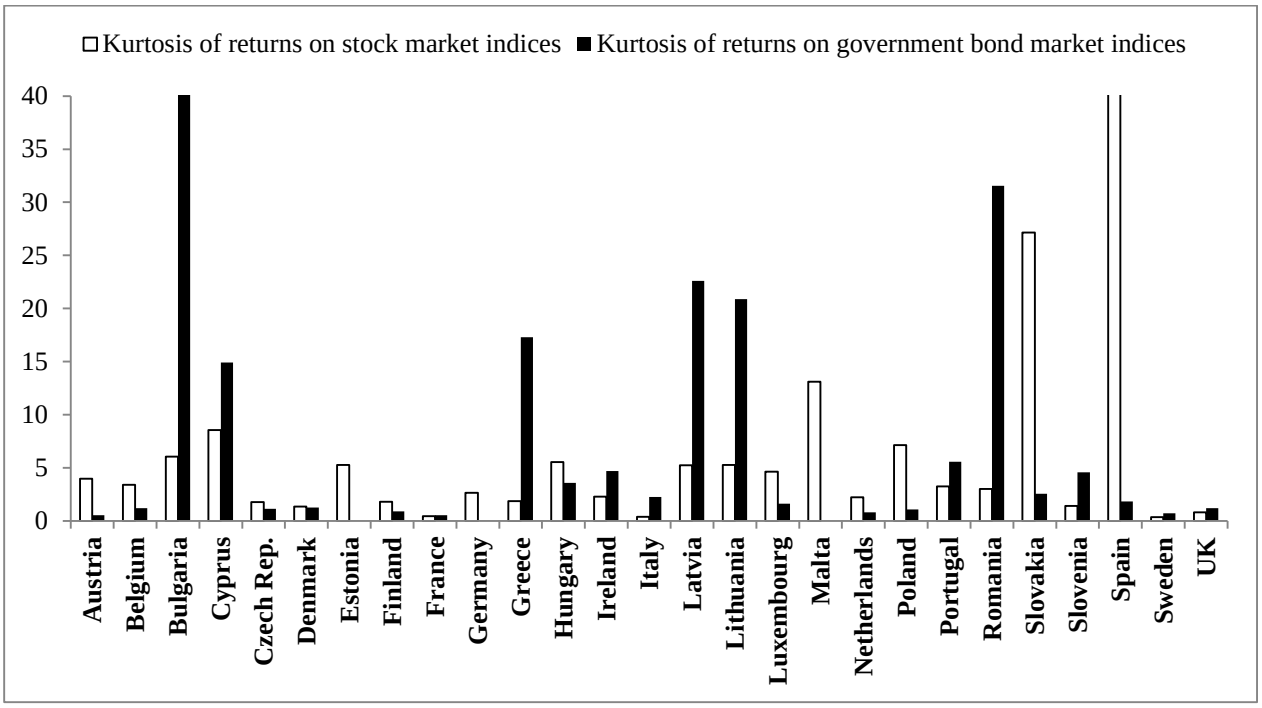
Skewness of returns on stock and government bond market indices in EU countries in 1993-2013



Source: author's calculations, based on *Thomson Reuters* data.

Appendix 9

Kurtosis of returns on stock and government bond market indices in EU countries in 1993-2013



Source: author's calculations, based on *Thomson Reuters* data.

Appendix 10

Correlation matrix between stock indices in EU countries in 1993-2013

	AT	BE	BG	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LV	LT	LU	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK
AT	1	**,738****	,236**	,164*	,285**	,255**	,088	,191**	,646**	,639**	,169**	,133*	,244**	,212**	,249**	,217**	,322**	,032	**,713****	,212**	,179**	,256**	-,055	,130	,332**	,272**	**,703****
BE	**,738****	1	,203*	,174**	,212**	,218**	,029	,104	**,795****	**,742****	,143*	,128*	,161*	,157*	,248**	,224**	,237**	-,026	**,837****	,118	,168**	,204**	-,025	,127	,363**	,230**	**,766****
BG	,236**	,203*	1	,430**	,526**	,437**	,526**	,428**	,083	,043	,472**	,480**	,258**	,446**	,391**	,536**	,474**	,136	,076	,410**	,365**	,540**	,433**	,486**	,079	,381**	,065
CY	,164*	,174**	,430**	1	,328**	,334**	,226**	,390**	,131*	,135*	,514**	,294**	,259**	,329**	,217**	,310**	,435**	,075	,152*	,181**	,321**	,259**	,046	,526**	,078	,378**	,110
CZ	,285**	,212**	,526**	,328**	1	,526**	,451**	,493**	,209**	,187**	,485**	,674**	,429**	,494**	,323**	,498**	,605**	,053	,198**	,625**	,496**	,606**	,285**	,395**	,157*	,455**	,143*
DK	,255**	,218**	,437**	,334**	,526**	1	,388**	,662**	,118	,101	,530**	,561**	,580**	,682**	,432**	,403**	,692**	,000	,146*	,390**	,584**	,280**	,144*	,404**	,030	,698**	,063
EE	,088	,029	,526**	,226**	,451**	,388**	1	,335**	-,045	-,036	,245**	,431**	,298**	,354**	,461**	**,737****	,515**	,073	,001	,345**	,350**	,370**	,240**	,396**	-,041	,321**	-,011
FI	,191**	,104	,428**	,390**	,493**	,662**	,335**	1	,133*	,133*	,525**	,596**	,604**	,688**	,300**	,375**	,654**	,131	,170**	,521**	,584**	,314**	,095	,396**	,049	**,817****	,053
FR	,646**	**,795****	,083	,131*	,209**	,118	-,045	,133*	1	**,873****	,111	,129*	,125	,101	,081	,137	,120	,143*	**,872****	,086	,132*	,141	-,087	,076	,462**	,181**	**,822****
DE	,639**	**,742****	,043	,135*	,187**	,101	-,036	,133*	**,873****	1	,052	,065	,106	,095	,069	,113	,113	,113	**,861****	,079	,152*	,097	-,093	,063	,433**	,158*	**,787****
EL	,169**	,143*	,472**	,514**	,485**	,530**	,245**	,525**	,111	,052	1	,530**	,412**	,552**	,325**	,377**	,544**	,057	,139*	,379**	,553**	,439**	,126	,537**	,027	,501**	,055
HU	,133*	,128*	,480**	,294**	,674**	,561**	,431**	,596**	,129*	,065	,530**	1	,452**	,528**	,317**	,459**	,626**	,038	,132*	,530**	,616**	,539**	,322**	,499**	,048	,541**	,024
IE	,244**	,161*	,258**	,259**	,429**	,580**	,298**	,604**	,125	,106	,412**	,452**	1	,560**	,310**	,269**	,569**	,032	,157*	,393**	,528**	,273**	,088	,265**	,031	,592**	,046
IT	,212**	,157*	,446**	,329**	,494**	,682**	,354**	,688**	,101	,095	,552**	,528**	,560**	1	,328**	,350**	,671**	,069	,149*	,389**	,688**	,363**	,039	,422**	,009	,677**	,075
LV	,249**	,248**	,391**	,217**	,323**	,432**	,461**	,300**	,081	,069	,325**	,317**	,310**	,328**	1	,458**	,331**	,093	,145	,282**	,170*	,302**	,129	,351**	,107	,270**	,087
LT	,217**	,224**	,536**	,310**	,498**	,403**	**,737****	,375**	,137	,113	,377**	,459**	,269**	,350**	,458**	1	,436**	,102	,132	,395**	,363**	,359**	,190*	,418**	,114	,307**	,105
LU	,322**	,237**	,474**	,435**	,605**	,692**	,515**	,654**	,120	,113	,544**	,626**	,569**	,671**	,331**	,436**	1	,111	,160*	,618**	,562**	,416**	,179*	,500**	,092	,660**	,048
MT	,032	-,026	,136	,075	,053	,000	,073	,131	,143*	,113	,057	,038	,032	,069	,093	,102	,111	1	,129	,037	,090	,013	-,009	,168	,052	,084	,100
NL	**,713****	**,837****	,076	,152*	,198**	,146*	,001	,170**	**,872****	**,861****	,139*	,132*	,157*	,149*	,145	,132	,160*	,129	1	,124	,177**	,181*	-,105	,075	,431**	,228**	**,831****
PL	,212**	,118	,410**	,181**	,625**	,390**	,345**	,521**	,086	,079	,379**	,530**	,393**	,389**	,282**	,395**	,618**	,037	,124	1	,469**	,474**	,202**	,395**	-,268**	,479**	,076
PT	,179**	,168**	,365**	,321**	,496**	,584**	,350**	,584**	,132*	,152*	,553**	,616**	,528**	,688**	,170*	,363**	,562**	,090	,177**	,469**	1	,347**	,112	,484**	-,052	,648**	,086
RO	,256**	,204**	,540**	,259**	,606**	,280**	,370**	,314**	,141	,097	,439**	,539**	,273**	,363**	,302**	,359**	,416**	,013	,181*	,474**	,347**	1	,207**	,442**	,124	,280**	,120
SK	-,055	-,025	,433**	,046	,285**	,144*	,240**	,095	-,087	-,093	,126	,322**	,088	,039	,129	,190*	,179*	-,009	-,105	,202**	,112	,207**	1	,091	-,099	,011	-,148*
SI	,130	,127	,486**	,526**	,395**	,404**	,396**	,396**	,076	,063	,537**	,499**	,265**	,422**	,351**	,418**	,500**	,168	,075	,395**	,484**	,442**	,091	1	,069	,347**	,044
ES	,332**	,363**	,079	,078	,157*	,030	-,041	,049	,462**	,433**	,027	,048	,031	,009	,107	,114	,092	,052	,431**	-,268**	-,052	,124	-,099	,069	1	,015	,443**
SE	,272**	,230**	,381**	,378**	,455**	,698**	,321**	**,817****	,181**	,158*	,501**	,541**	,592**	,677**	,270**	,307**	,660**	,084	,228**	,479**	,648**	,280**	,011	,347**	,015	1	,146*
UK	**,703****	**,766****	,065	,110	,143*	,063	-,011	,053	**,822****	**,787****	,055	,024	,046	,075	,087	,105	,048	,100	**,831****	,076	,086	,120	-,148*	,044	,443**	,146*	1

Note: * indicates a significant correlation at the 0.05 level of significance; ** indicates a significant correlation at the 0.01 level of significance

Source: calculations of the author, based on *Thomson Reuters* data.

Appendix 11

Correlation matrix between government bond indices in EU countries in 1993-2013

	AT	BE	BG	CY	CZ	DK	EE	FI	FR	DE	EL	HU	IE	IT	LV	LT	LU	MT	NL	PL	PT	RO	SK	SI	ES	SE	UK
AT	1	**,881****	-0,164	0,174	,566**	**,866****	.a	**,844****	**,915****	**,937****	-0,006	0,147	,630**	,573**	,270**	280**	,646**	.a	**,946****	,401**	,361**	0,082	,393**	,518**	,567**	**,747****	**,783****
BE	**,881****	1	-0,144	,269*	,533**	**,766****	.a	**,786****	**,846****	**,826****	0,065	0,143	,678**	,655**	0,193	,215*	,550**	.a	**,850****	,388**	,316**	0,06	,378**	,553**	,654**	,691**	**,708****
BG	-0,164	-0,144	1	,499**	-,266*	-0,042	.a	-0,118	-,212*	-0,054	0,005	0,018	-0,03	0,134	0,111	0,07	-0	.a	-0,133	-0,041	0,177	0,128	-0,041	0,141	0,158	-0,04	-0,031
CY	0,174	,269*	,499**	1	0,136	0,155	.a	0,105	,272*	0,12	0,141	,426**	0,015	,328**	,401**	379**	,275*	.a	0,133	,384**	0,066	,466**	0,19	0,185	0,088	0,096	,224*
CZ	,566**	,533**	-,266*	0,136	1	,405**	.a	,542**	,476**	,481**	0,153	,378**	,455**	,457**	,374**	462**	,402**	.a	,523**	,527**	,218**	,209*	,336**	,403**	,437**	,451**	,351**
DK	**,866****	**,766****	-0,042	0,155	,405**	1	.a	**,837****	**,867****	**,882****	-,161*	0,07	,550**	,497**	0,175	0,15	,582**	.a	**,868****	,340**	,266**	0,012	,257*	0,197	,528**	**,830****	**,773****
EE	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a
FI	**,844****	**,786****	-0,118	0,105	,542**	**,837****	.a	1	**,788****	**,836****	-0,038	0,099	,553**	,549**	,214*	,206*	,620**	.a	**,844****	,371**	,332**	0,014	,381**	,500**	,571**	**,849****	**,734****
FR	**,915****	**,846****	-,212*	,272*	,476**	**,867****	.a	**,788****	1	**,897****	-0,066	0,109	,589**	,599**	0,151	0,15	,575**	.a	**,914****	,367**	,278**	-0,014	,346**	,425**	,559**	**,735****	**,776****
DE	**,937****	**,826****	-0,054	0,12	,481**	**,882****	.a	**,836****	**,897****	1	-0,067	0,03	,550**	,522**	0,127	0,07	,613**	.a	**,959****	,350**	,306**	-0,094	,377**	,434**	,537**	**,784****	**,820****
EL	-0,006	0,065	0,005	0,141	0,153	-,161*	.a	-0,038	-0,066	-0,067	1	,327**	,321**	,287**	0,089	0,17	0,109	.a	-0,111	,180*	,488**	0,151	0,153	0,209	,349**	-0,15	-0,101
HU	0,147	0,143	0,018	,426**	,378**	0,07	.a	0,099	0,109	0,03	,327**	1	,272**	,270**	,600**	623**	,270**	.a	0,08	,506**	,221**	,475**	,231*	0,223	,214**	0,017	0,069
IE	,630**	,678**	-0,03	0,015	,455**	,550**	.a	,553**	,589**	,550**	,321**	,272**	1	,578**	0,188	282**	,366**	.a	,579**	,289**	,539**	0,1	,299**	,447**	**,705****	,472**	,543**
IT	,573**	,655**	0,134	,328**	,457**	,497**	.a	,549**	,599**	,522**	,287**	,270**	,578**	1	,247*	289**	,455**	.a	,534**	,386**	,438**	,215*	,290**	,656**	**,832****	,539**	,466**
LV	,270**	0,193	0,111	,401**	,374**	0,175	.a	,214*	0,151	0,127	0,089	,600**	0,188	,247*	1	**924****	,406**	.a	0,19	,424**	0,131	**,723****	0,109	0,157	0,112	0,019	0,095
LT	,280**	,215*	0,071	,379**	,462**	0,145	.a	,206*	0,147	0,074	0,172	,623**	,282**	,289**	**,924****	1	,365**	.a	0,175	,432**	,208*	**,774****	0,113	0,208	0,17	-0,042	0,036
LU	,646**	,550**	-0,002	,275*	,402**	,582**	.a	,620**	,575**	,613**	0,109	,270**	,366**	,455**	,406**	365**	1	.a	,616**	,324**	,244**	,413**	,283**	,371**	,399**	,481**	,501**
MT	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a	.a
NL	**,946****	**,850****	-0,133	0,133	,523**	**,868****	.a	**,844****	**,914****	**,959****	-0,111	0,08	,579**	,534**	0,19	0,18	,616**	.a	1	,350**	,268**	-0,015	,341**	,469**	,541**	**,771****	**,813****
PL	,401**	,388**	-0,041	,384**	,527**	,340**	.a	,371**	,367**	,350**	,180*	,506**	,289**	,386**	,424**	432**	,324**	.a	,350**	1	,213*	,310**	,262**	,310*	,340**	,320**	,358**
PT	,361**	,316**	0,177	0,066	,218**	,266**	.a	,332**	,278**	,306**	,488**	,221**	,539**	,438**	0,131	,208*	,244**	.a	,268**	,213*	1	0,144	,252*	,420**	,462**	,269**	,255**
RO	0,082	0,06	0,128	,466**	,209*	0,012	.a	0,014	-0,014	-0,094	0,151	,475**	0,1	,215*	**,723****	**774****	,413**	.a	-0,015	,310**	0,144	1	0,042	0,083	0,086	-,235*	-0,042
SK	,393**	,378**	-0,041	0,19	,336**	,257*	.a	,381**	,346**	,377**	0,153	,231*	,299**	,290**	0,109	0,11	,283**	.a	,341**	,262**	,252*	0,042	1	,572**	,244*	,289**	0,198
SI	,518**	,553**	0,141	0,185	,403**	0,197	.a	,500**	,425**	,434**	0,209	0,223	,447**	,656**	0,157	0,21	,371**	.a	,469**	,310*	,420**	0,083	,572**	1	,576**	0,235	0,251
ES	,567**	,654**	0,158	0,088	,437**	,528**	.a	,571**	,559**	,537**	,349**	,214**	**,705****	**,832****	0,112	0,17	,399**	.a	,541**	,340**	,462**	0,086	,244*	,576**	1	,563**	,500**
SE	**,747****	,691**	-0,04	0,096	,451**	**,830****	.a	**,849****	**,735****	**,784****	-0,15	0,017	,472**	,539**	0,019	-0,04	,481**	.a	**,771****	,320**	,269**	-,235*	,289**	0,235	,563**	1	,692**
UK	**,783****	**,708****	-0,031	,224*	,351**	**,773****	.a	**,734****	**,776****	**,820****	-0,101	0,069	,543**	,466**	0,095	0,04	,501**	.a	**,813****	,358**	,255**	-0,042	0,198	0,251	,500**	,692**	1

Note: * indicates a significant correlation at the 0.05 level of significance; ** indicates a significant correlation at the 0.01 level of significance

Source: calculations of the author, based on *Thomson Reuters* data.

Appendix 12

Average sovereign ratings, downgrades and updates of EU countries in 2005-2012

	Average Ratings		Number of Downgrades		Number of Upgrades	
	Fitch	S&P	Fitch	S&P	Fitch	S&P
Austria	25.00	24.91	-	1	-	-
Belgium	23.74	23.89	1	1	1	-
Cyprus	20.75	19.68	4	6	1	1
Estonia	19.76	20.17	2	1	2	2
Finland	25.00	25.00	-	-	-	-
France	25.00	24.91	-	1	-	-
Germany	25.00	25.00	-	-	-	-
Greece	17.29	16.67	8	8	1	1
Ireland	22.88	22.98	4	6	-	-
Italy	21.93	20.92	3	3	-	-
Luxembourg	25.00	25.00	-	-	-	-
Malta	20.67	19.91	-	1	1	-
Netherlands	25.00	25.00	-	-	-	-
Portugal	21.39	20.18	5	5	-	-
Slovak R.	20.45	20.29	-	1	2	2
Slovenia	22.49	22.61	3	3	1	1
Spain	24.18	23.80	4	5	-	-
Bulgaria	16.42	17.16	1	1	1	2
Czech R.	20.51	19.92	-	-	2	2
Denmark	25.00	25.00	-	-	-	-
Hungary	17.30	17.13	4	4	-	-
Latvia	17.08	16.70	4	5	1	2
Lithuania	18.33	18.30	3	3	1	1
Poland	18.74	18.72	-	-	1	1
Romania	15.95	15.40	1	1	2	1
Sweden	25.00	25.00	-	-	-	-
UK	25.00	25.00	-	-	-	-

Source: J. Alzenman, M. Binici and M. Mutchison (2013)

Appendix 13

Correlations between stock and government bond indices in EU countries in 1993-2013

Correlations				Correlations				Correlations			
		AustriaS	AustriaB			GermanyS	GermanyB			NetherlandsS	NetherlandsB
AustriaS	Pearson Correlation	1	,080	GermanyS	Pearson Correlation	1	-,019	NetherlandsS	Pearson Correlation	1	,056
	Sig. (2-tailed)		,216		Sig. (2-tailed)		,774		Sig. (2-tailed)		,389
	N	240	240		N	240	240		N	240	240
Correlations				**Correlations**				**Correlations**			
		BelgiumS	BelgiumB			GreeceS	GreeceB			PolandS	PolandB
BelgiumS	Pearson Correlation	1	,153*	GreeceS	Pearson Correlation	1	,448**	PolandS	Pearson Correlation	1	,213*
	Sig. (2-tailed)		,018		Sig. (2-tailed)		,000		Sig. (2-tailed)		,011
	N	240	240		N	240	166		N	240	142
Correlations				**Correlations**				**Correlations**			
		BulgariaS	BulgariaB			HungaryS	HungaryB			PortugalS	PortugalB
BulgariaS	Pearson Correlation	1	,010	HungaryS	Pearson Correlation	1	,477**	PortugalS	Pearson Correlation	1	,177**
	Sig. (2-tailed)		,926		Sig. (2-tailed)		,000		Sig. (2-tailed)		,007
	N	148	92		N	240	149		N	240	234
Correlations				**Correlations**				**Correlations**			
		CyprusS	CyprusB			IrelandS	IrelandB			RomaniaS	RomaniaB
CyprusS	Pearson Correlation	1	,146	IrelandS	Pearson Correlation	1	-,006	RomaniaS	Pearson Correlation	1	,444**
	Sig. (2-tailed)		,198		Sig. (2-tailed)		,924		Sig. (2-tailed)		,000
	N	240	80		N	240	239		N	185	97
Correlations				**Correlations**				**Correlations**			
		Czech_Republic_S	Czech_Republic_B			ItalyS	ItalyB			SlovakiaS	SlovakiaB
Czech_Republic_S	Pearson Correlation	1	,121	ItalyS	Pearson Correlation	1	,260**	SlovakiaS	Pearson Correlation	1	,027
	Sig. (2-tailed)		,136		Sig. (2-tailed)		,000		Sig. (2-tailed)		,796
	N	226	152		N	240	240		N	233	97
Correlations				**Correlations**				**Correlations**			
		DenmarkS	DenmarkB			LatviaS	LatviaB			SloveniaS	SloveniaB
DenmarkS	Pearson Correlation	1	-,015	LatviaS	Pearson Correlation	1	,204*	SloveniaS	Pearson Correlation	1	,045
	Sig. (2-tailed)		,814		Sig. (2-tailed)		,045		Sig. (2-tailed)		,731
	N	240	240		N	157	97		N	128	61
Correlations				**Correlations**				**Correlations**			
		EstoniaS	EstoniaB			LithuaniaS	LithuaniaB			SpainS	SpainB
EstoniaS	Pearson Correlation	1	.[a]	LithuaniaS	Pearson Correlation	1	,515**	SpainS	Pearson Correlation	1	-,026
	Sig. (2-tailed)		.		Sig. (2-tailed)		,000		Sig. (2-tailed)		,686
	N	200	0		N	157	97		N	240	240
Correlations				**Correlations**				**Correlations**			
		FinlandS	FinlandB			LuxembourgS	LuxembourgB			SwedenS	SwedenB
FinlandS	Pearson Correlation	1	-,120	LuxembourgS	Pearson Correlation	1	-,140	SwedenS	Pearson Correlation	1	-,071
	Sig. (2-tailed)		,063		Sig. (2-tailed)		,070		Sig. (2-tailed)		,274
	N	240	240		N	169	169		N	240	240
Correlations				**Correlations**				**Correlations**			
		FranceS	FranceB			MaltaS	MaltaB			United_Kingdom_S	United_Kingdom_B
FranceS	Pearson Correlation	1	,052	MaltaS	Pearson Correlation	1	.[a]	United_Kingdom_S	Pearson Correlation	1	,067
	Sig. (2-tailed)		,424		Sig. (2-tailed)		.		Sig. (2-tailed)		,302
	N	240	240		N	205	0		N	240	240

Source: author's calculations, based on *Thomson Reuters* data.

Appendix 14

Summarized data of rolling correlations between stock and government bond indices in EU countries in 1992-2013

COUNTRY	AT	BE	BG	CY	CZ	DK	FI	FR	DE	EL	HU	IE	IT
Standard deviation	28,55%	33,49%	31,01%	29,79%	31,53%	48,63%	40,87%	29,78%	25,78%	41,67%	26,66%	38,08%	40,81%
Min	-0,82	-0,56	-0,51	-0,59	-0,76	-0,76	-0,79	-0,69	-0,81	-0,81	-0,35	-0,73	-0,70
Max	0,63	0,86	0,75	0,64	0,66	0,89	0,79	0,79	0,66	0,96	0,89	0,76	0,88
Average	0,14	0,15	0,18	0,05	0,07	0,00	-0,18	0,07	0,05	0,02	0,43	-0,02	0,13
Skewness	-0,65	-0,12	-0,44	0,06	-0,57	0,36	0,60	0,30	-0,06	0,29	-0,65	0,14	-0,03
Kurtosis	0,07	-0,85	-0,65	-0,49	-0,38	-1,25	-0,68	-0,69	-0,21	-0,62	-0,04	-0,87	-1,09
COUNTRY	LV	LT	LU	NL	PL	PT	RO	SK	SI	ES	SE	UK	
Standard deviation	23,22%	39,30%	26,86%	29,51%	26,21%	40,54%	41,17%	31,20%	20,05%	26,91%	46,46%	34,97%	
Min	-0,33	-0,54	-0,71	-0,77	-0,59	-0,80	-0,60	-0,64	-0,53	-0,63	-0,90	-0,81	
Max	0,67	0,81	0,36	0,78	0,62	0,80	0,85	0,63	0,28	0,80	0,81	0,79	
Average	0,09	0,22	-0,14	0,11	0,01	0,05	0,35	-0,05	0,00	0,12	-0,15	0,07	
Skewness	0,13	0,06	-0,20	0,01	0,08	-0,12	-0,66	-0,05	-0,47	0,11	0,33	0,09	
Kurtosis	-0,79	-1,37	-0,96	-0,41	0,09	-0,83	-0,74	-0,88	-0,61	-0,47	-0,99	-0,77	

Source: calculations of the author, based on *Thomson Reuters* data

Appendix 15

Correlations between stock and government bond indices in EU countries in 2008-2013

Correlations				Correlations				Correlations			
		AustriaS	AustriaB			GermanyS	GermanyB			NetherlandsS	NetherlandsB
AustriaS	Pearson Correlation	1	-,006	GermanyS	Pearson Correlation	1	-,016	NetherlandsS	Pearson Correlation	1	,066
	Sig. (2-tailed)		,963		Sig. (2-tailed)		,905		Sig. (2-tailed)		,612
	N	61	61		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		BelgiumS	BelgiumB			GreeceS	GreeceB			PolandS	PolandB
BelgiumS	Pearson Correlation	1	,267*	GreeceS	Pearson Correlation	1	,594**	PolandS	Pearson Correlation	1	,389**
	Sig. (2-tailed)		,037		Sig. (2-tailed)		,000		Sig. (2-tailed)		,002
	N	61	61		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		BulgariaS	BulgariaB			HungaryS	HungaryB			PortugalS	PortugalB
BulgariaS	Pearson Correlation	1	-,010	HungaryS	Pearson Correlation	1	,620**	PortugalS	Pearson Correlation	1	,328**
	Sig. (2-tailed)		,939		Sig. (2-tailed)		,000		Sig. (2-tailed)		,010
	N	61	56		N	61	60		N	61	61
Correlations				**Correlations**				**Correlations**			
		CyprusS	CyprusB			IrelandS	IrelandB			RomaniaS	RomaniaB
CyprusS	Pearson Correlation	1	,163	IrelandS	Pearson Correlation	1	,001	RomaniaS	Pearson Correlation	1	,538**
	Sig. (2-tailed)		,252		Sig. (2-tailed)		,995		Sig. (2-tailed)		,000
	N	61	51		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		Czech_Republic_S	Czech_Republic_B			ItalyS	ItalyB			SlovakiaS	SlovakiaB
Czech_Republic_S	Pearson Correlation	1	,117	ItalyS	Pearson Correlation	1	,234	SlovakiaS	Pearson Correlation	1	-,123
	Sig. (2-tailed)		,369		Sig. (2-tailed)		,070		Sig. (2-tailed)		,344
	N	61	61		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		DenmarkS	DenmarkB			LatviaS	LatviaB			SloveniaS	SloveniaB
DenmarkS	Pearson Correlation	1	-,395**	LatviaS	Pearson Correlation	1	,235	SloveniaS	Pearson Correlation	1	,045
	Sig. (2-tailed)		,002		Sig. (2-tailed)		,068		Sig. (2-tailed)		,731
	N	61	61		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		EstoniaS	EstoniaB			LithuaniaS	LithuaniaB			SpainS	SpainB
EstoniaS	Pearson Correlation	1	.[a]	LithuaniaS	Pearson Correlation	1	,589**	SpainS	Pearson Correlation	1	,123
	Sig. (2-tailed)		.		Sig. (2-tailed)		,000		Sig. (2-tailed)		,343
	N	61	0		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		FinlandS	FinlandB			LuxembourgS	LuxembourgB			SwedenS	SwedenB
FinlandS	Pearson Correlation	1	-,399**	LuxembourgS	Pearson Correlation	1	,023	SwedenS	Pearson Correlation	1	-,456**
	Sig. (2-tailed)		,001		Sig. (2-tailed)		,858		Sig. (2-tailed)		,000
	N	61	61		N	61	61		N	61	61
Correlations				**Correlations**				**Correlations**			
		FranceS	FranceB			MaltaS	MaltaB			United_Kingdom_S	United_Kingdom_B
FranceS	Pearson Correlation	1	,123	MaltaS	Pearson Correlation	1	.[a]	United_Kingdom_S	Pearson Correlation	1	,060
	Sig. (2-tailed)		,347		Sig. (2-tailed)		.		Sig. (2-tailed)		,649
	N	61	61		N	61	0		N	61	61

Source: calculations of the author, based on Thomson Reuter's data.