Academic year 2014-2015

Master's Degree in Economics of Globalisation and European Integration

Is the European Monetary Union an optimal currency area? An empirical analysis of interest rate and inflation differentials across the euro zone

Master dissertation

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Submission date	September 2015

Acknowledgments:

I would like to express my sincerest thanks to Marcel Bluhm for his guidance, support, patience and valuable recommendations.

Declaration of authorship:

I, Ondřej Gúth, hereby declare that the thesis “Is the European Monetary Union an optimal Currency area? An empirical analysis of interest rate and inflation differentials across the euro zone" was written by myself, and that all presented results are my own, unless stated otherwise. The literature sources are listed in the References section.

Prague, September, 2015

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Abstract

The economic crisis of 2008 had substantial impacts on the global economy. The European Monetary Union was affected as well, however, the economic impacts also stirred up political discussions concerning functioning of the European Union and its unity as divergence of economic means among the member countries intensified during the crisis. Inflation and real interest rate differentials have to substantial degree the ability to measure the divergence among the member countries of a monetary union. A number of empirical studies measuring the differentials in the Euro area were conducted since the start of the financial crisis in 2008. These studies show growing inflation and real interest rate differentials among the countries of the Euro area, argue that the European Monetary Union is becoming less stable and often question its future. This paper conducts similar empirical analysis; however, it differs from the above mentioned works of other authors by the larger time gap between the start of financial crisis and the time of conducting the analysis as it uses data until the year of 2013. This paper also contributes to current literature by the methodology it uses. The inflation and interest rate differentials in EMU are calculated by two methods and their results are subsequently compared, which has not been done before. The inflation and interest rate differentials are calculated for the USA as well in order to have an entity which can be considered as a hypothetical optimum currency area and to which the differentials of EMU could be compared. The results of the analysis in this paper will state whether the magnitude of inflation and interest rate differentials is too high and it will also either confirm the trend of divergence of inflation and real interest rates within the Euro area or show that this divergence is only a short-time period phenomenon of after-crisis years. As this is an important and very recent issue of European Monetary Union the results of this paper should form interesting contribution to current literature on this topic.

Key words

Inflation differentials, Interest rate differentials, One size does not fit all, European Monetary Union, EMU, European Union, EU, Euro zone,

List of abbreviations

CPI	Consumer Price Index
ECB	European Central Bank
EMU	European Monetary Union
EU	European Union
GDP	Gross Domestic Product
GIIPS	Greece, Italy, Ireland, Portugal, Spain
GSP	Gross State Product
HICP	Harmonized Index of Consumer Prices
IMF	International Monetary Fund
IR	Interest Rate
OECD	Organization for Economic Co-operation and Development
UNCTAD	United Nations Conference on Trade and Development
USA	United States of America

Literature review

The literature connected with inflation and interest rate differentials in EMU is relatively recent. First analysis of cross-country inflation differentials was done by Alberola (2000). He concludes that both tested forces, convergence of prices and nation-specific cyclical factors do influence inflation differentials. The most detailed theoretical analysis of inflation and interest rate differentials was carried by ECB (2003). This paper is later often quoted as it is the first paper to categorize reasons for emergence of inflation and interest rate differentials and sets channels of their influence on the economy. Honohan and Lane (2003) moved the topic of inflation differentials from theory-based description to econometric analysis. They run a multivariate regression showing that much of inflation differentials in the first years of the EMU is attributable to common external exchange rates.

Arnold and Kool (2003) analyzed inflation and interest rate differentials in the USA. They found that economy of the USA is more integrated and more flexible than other single currency areas, however, the differentials are present as well. They also performed a comparison to EMU stating that EMU needs improvement of functioning and integration of labour, product and housing markets

Angeloni and Ehrmann (2004) argue that inflation differentials will remain prominent in EMU and will increase with increasing number of participants of the common currency. They conclude that persistence of inflation differentials in EMU is significant.

Favero (2011) describes three development stages of inflation and interest rate differentials. The pre-EMU period when interest rate differentials reflected different inflation levels in European countries, the period of sharp decrease of both inflation and interest rate differentials after the constitution of EMU until 2008 and the third period after the financial crisis of 2008 when interest rate differentials start to diverge.

Darvas and Wolff (2014) prove that inflation differentials are present not only in EMU, but also in the USA, Canada or Japan. They also argue that central banks cannot control inflation differentials with their single interest rate instrument and unconventional policy measures are necessary.

On the other hand Issing (2005) argues that inflation differentials are natural part of a monetary union and do not represent a threat to its functioning. A central bank can use instruments that can restrain their negative effects.

Apart from empirical studies the literature on theory of optimum currency area is also used in this paper. Four basic papers forming this theory are Mundell (1961) who argues that

labour mobility is necessary in a monetary union; McKinnon (1963) stated that level of openness is another important variable for a country joining monetary union, Kenen (1969) added the importance of similar structure of countries in a single currency area and Fleming (1971) added that when a country joins a monetary union it joins a wide-set preferences of inflation rate, output growth and unemployment.

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Introduction

European Monetary Union is probably the most debated single currency area in the academic sphere. Its functioning, internal processes and the decision-making of the whole European Union is interesting in terms of politics and economics as it is often questioned and labeled as ineffective in public surveys and as it became a topic of not a few academic papers. The establishment, functioning and future of the common currency, the euro, faces the same attention. Inflation and interest rate differentials in European Monetary Union have become an intermediate measure for the problems of the euro area in the academic sphere as they can embody the divergence among the euro zone member states. The goal of this dissertation is to analyze the inflation and real interest rate differentials in the European Monetary Union and to answer the question, whether it can be labeled in relation to the differentials as an optimum currency area. The hypothesis of this paper is: "There are no significant inflation and interest rate differentials in the European Monetary Union."

Academic sphere has produced a theory which describes the characteristics that countries joining a monetary union should have, this branch of economics is called optimum currency area theory. In the first part of this dissertation the findings of the theory, which is composed of four main works published in 1960's and early 1970's by four authors, Mundell, Kenen, McKinnon and Fleming, are analyzed in order to characterize what properties an optimum currency area member states should feature. The inflation differentials are defined and their connection to the optimum currency area theory is explained. Next goal of the theoretical part is to define the relationship between inflation differentials and real interest rate differentials, which is done by introducing the Fisher's effect. Analysis of the causes that lead to emergence of inflation and real interest rate differentials follows and the analysis of impacts of these differentials on a monetary union in general is also added. At the end of the theoretical part the less spread point of view advocating the harmlessness of inflation and real interest rate differentials is presented as well.

Second part of this dissertation is composed of the empirical analysis of inflation and interest rate differentials in the European Monetary Union. In the first subsection of the empirical part analysis of historic development of inflation and interest rates differentials is performed. EMU is subsequently tested for the presence and magnitude of the differentials, which are subsequently analyzed. Second subsection is dedicated to the comparison of previously calculated differentials in EMU with the differentials of the United States of America, which are computed as well. This comparison answers the question whether the

value of the differentials in EMU is too high and whether member countries of the euro zone diverge in their economic developments.

1 Theory of inflation differentials

1.1 Traditional theories of optimum currency areas

Economic theory started to investigate single currency areas in the 1960s and since then it has found several variables which can be used for definition of such an area. Four main ideas are forming the traditional theories of optimal currency areas; modern theories that emerged later combine the ideas of initial four or bring different perspectives.

In 1961 Mundell stressed the importance of labour mobility. He argued that if an asymmetric demand shock hits single currency area, it can lead to increase in output and inflationary pressure in one region and a decrease of relative output and unemployment in other region of the same single currency area. Under the premise of labour mobility, labour will leave the area of unemployment, by which in will reduce this unemployment, and move to the area of higher inflationary pressure which will allow producing more output without further rise of inflation. Labour mobility can therefore substitute missing exchange rate balancing mechanism which would otherwise prevent inflation by appreciation and restore the demand by depreciation (Mundell 1961).

Second variable defining the optimum currency area is the level of openness, which was introduced by McKinnon in 1963. Main idea is that more open the country is before joining the monetary union, less dependent on devaluation of its currency it is as devaluation becomes less effective with higher degrees of openness. If a country could not rely on devaluation in the past it will not need this channel in the future when it joins monetary union and lose the opportunity of devaluation of its currency. (McKinnon 1963)

Countries that will join a monetary union should be very similar in the structure of their economy. This argument was introduced by Kenen in 1969 and is the third main idea of the traditional optimum currency area theory. If member countries of a monetary union are much diversified in the structure and a symmetric shock hits one sector of all economies, a country depending on this sector will be negatively influenced much more than others. The levels of output growth and consequently also inflation level (apart from other macroeconomic indicators) will be therefore different in each country. Different structures of economies cause imbalances within monetary union which bring further costs. More similar countries joining the monetary union are, lower are the costs of joining the union (Kenen, 1969).

The fourth variable was defined by Fleming in 1971 and it concerns different inflation preferences among countries joining the single currency area. The country that joins a

monetary union also enters union-wide set of preferences of inflation level, output growth and unemployment. This means that if two countries in monetary union intrinsically grow at uneven rates, the faster growing country will be limited by the growth rate of the slower country as there is no possibility of devaluation and no balance of payment deficit. Similar situation arises if two countries have different inflation rates. If these countries are not in a monetary union the difference in inflation rates is balanced via exchange rate fluctuation which is impossible in a monetary union and both countries have to accept same inflation rate (Fleming, 1971). This scenario is based on the assumption that there must be only one inflation rate in the economy and existence of inflation differentials is thought of as impossible, so both countries in this example have to accept only one inflation rate. In real world, inflation differentials can exist so different inflation preferences can cause inflation differentials directly.

This paper focuses on the impacts of inflation differentials on functioning of a single currency area with emphasis on the European Monetary Union. Even though it might seem the first three traditional theories do not explain inflation differentials, it will be shown that inflation differentials can serve as an indicator as to whether even the first three conditions are sufficiently met.

1.2 Inflation differentials, real interest rate differentials and their impacts

Inflation differentials are differences in the inflation rates within states or regions, nowadays, this term is in the economic literature usually connected with the differences in inflation rates between the regions of a monetary union. A monetary union is an area with common currency, thus also with common central bank. According to the theory a central bank's goal should be to maintain price stability[1] (Chari and Kehoe, 2006), which can be achieved through an instrument of monetary policy. A monetary policy can change the interest rate or the money supply in the economy, which has an impact on price level (Koshy, 2012) and thus inflation in the whole area where the same currency is used. By using monetary policy the central bank can according to the situation boost the economy or on the other hand prevent its overheating. A central bank of one state can do this effectively, but a

[1] Even though it is recommended in the theory to central banks to have only one goal and most central banks abide by this recommendation, there is an exception of Federal Reserve System (FED), which is a successful central bank despite having two goals.

central bank of a monetary union has to face complications. If the regions within a monetary union do not have same or similar inflation rates, central bank may find itself paralyzed as these regional differences hamper the transmission of monetary policy (Darvas and Merler, 2013). For example restrictive monetary policy might be suitable for a region experiencing high inflation, but at the same time might lead to deflation in other region with very low inflation. If both mentioned regions are in the monetary union at the same time the central bank cannot use traditional policies to achieve price stability. This is the basic, even though rather simplified explanation of problems why inflation differentials cause problems.

Countries in a monetary union usually face the same nominal interest rate set by their monetary authorities. The relationship between nominal interest rate, inflation rate and real interest rate is described by the Fisher's effect. This theory argues that real interest rate equals the nominal interest rate minus expected inflation rate as is demonstrated by the following formula (Mankiw 2012):

$$\mathbf{r = i_{lt} - \pi^{e}}$$

Where r stands for real interest rate, i_{lt} is nominal interest rate and π^{e} stands for inflation rate. If the assumption of fixed interest rates among the regions of a monetary union is made, inflation differentials within this monetary union will cause emergence of real interest rate differentials which lead to further imbalances.

A country that grows faster than the average within the monetary union will experience higher inflationary pressure, which will in turn cause lower or even negative real interest rate (if the nominal interest rate is the same for the whole union). Lower real interest rate will promote further borrowing in the economy and even higher inflationary pressure. Opposite situation emerges when we consider a country that grows more slowly than the average of the monetary union. This country's inflation rate will be smaller than average and its real interest rate will be consequently higher than the average. High real interest rate restrains borrowing in the economy and hampers further growth. Inflation differences therefore cause "self-reinforcing internal imbalances" (Busetti et al, 2006). Above mentioned example show that a country that needs to strengthen its growth can be slowed by inflation differentials and a country that is overheating can experience further inflationary pressure.

Especially problematic are inflation differentials in the European Monetary Union as it lacks smoothing mechanisms that other single currency areas like United States usually have,

often mentioned are limited migration and labour mobility in European Union (Perotti, 2004). Euro zone also misses common fiscal system or a synchronized system influencing local fiscal policies. A basic fiscal coordination might be a common unemployment insurance which would diversify risks of sudden increase of welfare costs of a country due to increase of unemployment resulting from asymmetric shock. If such a shock hits one country, the costs of unemployment benefits are covered by all countries of a monetary union and the budget of affected country faces only limited pressure.

Fiscal policies are conducted on the national level, which not only does not help diminish the differentials; it also promotes them as fiscal policies in the European Union are pro-cyclical (IMF, 2004). These facts show that in other monetary unions (e.g. the USA) there are automatic mechanisms that prevent emergence of inflation differentials. European Monetary union is in more difficult position, as it has only its central bank to supplement these smoothing mechanisms.

1.3 Reasons for inflation differentials

Inflation differentials are caused by a number of aspects. Defining one measure that would have major influence on inflation differentials is hard, if not even impossible, as Rersperger (2003) suggests. The task is even more difficult as one reason for inflation differentials is usually interconnected with others. The differentiation of reason for emergence of inflation differentials is not standardized in the literature; different categories are used in studies on this topic. For example inflation differentials can be natural part of adjustment within monetary union and an intermediate of convergence; as such it can be regarded as a positive phenomenon. If a country joins monetary union and its price level before joining was not at exactly the same level as prices of the rest of the monetary union, it will need its inflation rate to be different from the rest of the monetary union in order to achieve the same price level. Price convergence of this country would therefore cause temporary inflation differential, which could be regarded as positive. On the other hand inflation differentials can also signify divergence, which is more common association with inflation differentials. Other differentiation of inflation differentials can be done according to the time horizon of their influence, sectoral or overall view or differentiation to external and internal sectors. In this

paper a differentiation of structural and cyclical reasons supplemented with consumption preferences used by ECB (2003) is used.

1.3.1 Consumption preferences and governmental influence

The first set of reasons why inflation differentials may be observed is rather statistic. Firstly, observed inflation differentials incorporate different consumption preferences. A study by European Central bank (ECB 2003) illustrates that inflation differentials do not show only differences in price developments of goods and services but they also incorporate differences in the shares of these goods and service in consumption of EMU countries. Using the same methodology in terms of same weights for construction of the basket of consumer goods and services for inflation measurement of all EMU countries causes inaccuracies and exaggerates the inflation differentials. This phenomenon is called the composition effect and is a reason why HICP (Harmonized Index of Consumer Prices) was introduced by ECB to measure the inflation levels in EMU countries. HICP uses different weights for consumer goods in a basket in different countries in order to avoid composition effect and to make resulting inflation rates comparable.

Second drawback mentioned by ECB (2003) is the influence of governments on inflation levels. Government can influence inflation by changes in indirect taxes and administered prices. These two channels can artificially influence inflation differentials; however, in case of EMU their impact is only limited as the same study proves and adds that they do not explain significant part of the cause of inflation differentials.

1.3.2 Structural reasons

The values of inflation differentials are also influenced by structural factors. Structural factors are according to ECB (2003) threefold: external effects, convergence of prices of tradable and non-tradable goods and market rigidities.

1.3.2.1 External effects

External effects represent factors that a government or a monetary authority cannot influence, for example a change in oil prices. If we presume there are different oil imports dependencies among the members of a monetary union, then the impact of a change of oil import price on the inflation level will have different proportions in different countries. This dependency can be measured as a percentage of GDP represented by oil imports. If we look at this measure, we find out that this dependency varies in the countries of European Monetary Union, least dependent is the Netherlands with approximately 1 % share and the most dependent is Luxembourg with approximately 3 % of share of oil imports on national GDP (ECB 2003). Dependency on oil imports is a good tangible example of external factors, in fact the external factors include changes of prices of all imports and different import structures within the members of Euro zone.

Even though there is only one currency in the monetary union an exchange rate channel can cause inflation differentials as well. Inflation can be imported via exchange rate mechanism and if member countries of the monetary union have not similar composition of their exports and imports from third (non-union) countries, movement of the central exchange rate will have different impact on each country's inflation rate, causing inflation differentials (Aldaroso 2009).

If the problem is seen from wider perspective, external factors in fact represent different structures of economies of member states of a monetary union, which is a criterion of optimum currency area described by Kenen in 1969 (see page 3), and it also partially reflects the degree of openness criterion described by McKinnon (1963).

1.3.2.2 Convergence of price of tradable goods

Convergence of price of tradable and non-tradable goods is the second part of structural reasons for inflation differentials. In the economic theory convergence of price of tradable goods is usually assumed as purchasing power parity and the law of one price should hold. However, differences in price of tradable goods exist in Euro area as is argued by ECB (2003). Four reasons for remaining price differences of tradable goods were defined by the European Commission (2002). The first is indirect taxation differences among the members of

Euro zone, second reason is imperfect competition, third inefficient service sectors and the last is structure of distribution channels.

Out of these four reasons only differences in indirect taxation can be fully addressed by intergovernmental harmonization. Implication of competition policies can mitigate the effects of imperfect competition, but it will never completely remove them as imperfect competition will always exist due to economies of scale and product differentiation (Kaldor, 1935). However, further reduction of trade-inhibiting regulation set up by member countries of EMU will help with inefficient service sector and the structure of distribution channels.

1.3.2.3 Convergence of price of non-tradable goods

Convergence of prices of non-tradable goods is associated with Balassa-Samuelson effect describing the differences in non-tradable goods prices. The differences in productivity growth between tradable and non-tradable goods sector is reflected by inflation differentials. Balassa-Samuelson theorem argues that increase in productivity of tradable goods sector will lead to the increase of wages in this sector without causing higher prices. As labour mobility between the two sectors is assumed the wages will also rise in non-tradable sector. This increase in wages larger than the increase in productivity in non-tradable sector will lead to higher increase of prices of goods in non-tradable sector. With higher productivity differences between non-tradable and tradable sectors will prices in non-tradable sector increase and thus overall inflation will increase as well (Asea and Corden, 1994). Historical data proves that since 1960's there are higher productivity growths in tradable sector and higher inflation rates in non-tradable sector in the European countries using Euro as their currency (ECB 2003). However, the differences in productivity growths in both sectors differ in each country. This implies that inflation growth resulting from Balassa-Samuelson theorem will be different in each country and thus causing inflation differentials. The resulting effect has impact on inflation only; level of competitiveness of countries is not affected as increase of wages in tradable sector is balanced by increase in productivity in this sector.

1.3.2.4 Market rigidities

Market rigidities form the third part of structural reasons for inflation differentials. Market rigidities like price and wage stickiness prevent effective and fast adjustment of wages

and prices in different stages of business cycles. Market rigidities also encompass low labour mobility, which is important smoothing mechanism in a monetary union. Consequences of its absence were described by Mundell and it forms on part of the theory of optimum currency areas (see page 3). Different level of market rigidities in each country of a monetary union cause different speed of adjustment to exogenous shocks which form, apart from other imperfections like loss of productivity, inflation differentials.

Market rigidities can be reduced by structural reforms which improve absorption of shocks (ECB, 2003). But structural reforms can have negative short term impacts on formation of prices and wages and thus inflation differentials. ECB (2003) describes two kinds of structural reforms, horizontal and vertical. Vertical reforms are focused on growth of particular industry. They will likely cause temporary increase in inflation until the price level in this sector and the rest of economy reach new stable rate. Horizontal reforms, like increase of demand and supply on the labour market, are likely to enhance the output growth in the whole economy and increase the overall inflation. If different structural reforms are conducted in the countries of a monetary union they will have different impacts on inflation rate of the particular countries and thus forming inflation differentials. This shows that the results of structural reforms are ambiguous in the short run; however, well implemented structural reforms do decrease market rigidities and also inflation differentials in the long run.

1.3.3 Cyclical reasons

Inflation differentials are also caused by different positions in business cycles of member countries of a monetary union. Inflation is dependent on the output gap, which is defined as the difference of actual and potential output. Countries with higher-than-average inflation experience higher-than-average output growth and countries with lower-than-average inflation experience lower-than-average output growth. Empirical evidence proves this direct proportion relationship between the stage of a cycle of a country and its inflation rate, see for example Blanchard (2001), OECD (2002), Rogers (2002) or Darvas and Wolff (2014). If the member countries of a monetary union are in the different stages of their cycles, they are also having different output gaps which cause different inflation rates and consequently inflation differentials. ECB (2003) also concludes that "C*onsiderable cross-country differences in employment and wage growth, wage drift and real credit growth*

appear to confirm that differences in inflation developments have, at least in part, been caused by differences in cyclical positions." (Page 39)

The literature investigated the question of how to synchronize business cycles of the countries with fixed exchange rates and offered the answer of more intensive inter-industry trade and higher degree of openness. Frankel and Rose (1998) define intra-industry trade as the crucial element in harmonization of business cycles and show that more profound openness and higher the share of intra industry trade, more synchronized the business cycles become.

1.4 Do inflation differentials matter?

Inflation differentials are usually connected in the current literature with the single currency areas, particularly with European monetary union. They became a frequently discussed topic after the 2008 financial crises as they were often interpreted as a measure of convergence of member countries and also as a measure for future stability of euro zone, or alternatively as an indicator for the danger of its breakdown. As was already mentioned, inflation differentials should prevent monetary policy to be conducted efficiently and thus form a threat, at least this is the hidden assumption often used when inflation differentials are described. This point of view is often summed as a "one size does not fit all" problem. However, opposite point of view supporting the idea of harmless inflation differentials can be found as well, even though it is not widespread or often quoted. One of the members of the Executive Board of European Central Bank promotes this idea in his speech (Issing, 2005) and supports it with three following arguments.

First argument is that when analyzing inflation and real interest rate differentials among euro zone countries, ex post measures are used instead of ex ante. Real interest rate differentials are computed as a difference between nominal interest rates and observed inflation rate which is labeled as ex post measure in the argumentation of Issing. It is argued that ex post inflation rates (inflation rates measured and published by national statistic bureaus) do not influence investment and consumption. On the other hand, according to Issing inflation expectations (ex ante measure) do influence these two measures. The explanation is that real interest rates influence decisions of economic agents on consumption and investment by changing the price today relative to tomorrow. Inflation expectations are more important

than actual rates and expectations can be formed by credible monetary policy with a goal of price stability. Issing argues that difference between inflation expectations in Euro zone countries are much smaller than inflation differentials measured in usual way. The consequence of this is that the values real interest rate differentials are only limited.

Second argument supporting the idea of harmless inflation differentials are stabilizing channels that balance negative effects of real interest rate differentials. Competitiveness changes form the first balancing channel. If a country experiences lower demand and consequently has lower inflation than the average and higher-than-average interest rate of the monetary union, lower inflation will increase competitiveness of this country and will consequently increase the demand for its goods, which will create inflationary pressure and inflation differentials will disappear. Presence of this channel was proved empirically in the years of 1999-2004 when all Euro zone countries experiencing inflation rate lower than the average also experienced increase in their competitiveness. Even though this balancing mechanism was rather slow, it was able to offset the differences in real interest rates. The second stabilizer is risk sharing role of a currency union. This balancing channel was described by Mundell (1973). Main idea is that in a monetary union, country specific shocks can be mitigated by portfolio diversification. A country with flexible exchange rates hit by a shock experiences currency devaluation which diminishes purchasing power of domestic assets denominated in local currency. A country hit by a shock can therefore buy less from abroad, which diminishes the welfare of its economic agents. If the same country is in a monetary union, the welfare loss from the shock will be replaced by emergence of inflation differential. Higher values of inflation differentials represent larger advantage of using shock absorbing and portfolio diversification role of single currency area. The portfolio diversification channel is also revised empirically. Mutual funds investment had share of only 10% in 1997. By the end of 2002 this share increased by twenty percentage points to 30%. In this time period international banking activity increased as well and increased possibility of diversification for all economic agents.

Third argument suggests that even though inflation differentials form difficulties for the central monetary authority and there is little a central bank of a monetary union could do about them since its goal is price stability, there is a way how this problem can be tackled. The right institutions to tackle the asymmetric shocks are national governments, national economic policies can respond to asymmetric shocks and to both regional and sectoral divergences by conducting structural reforms and fiscal policies. Structural reforms have been already mentioned in section 1.3.2.4, ECB stresses out that they should be conducted

especially in labour markets to increase labour mobility. Fiscal policies of member states can react to shocks even under the condition of presence of structural rigidities and in such a way prevent formation of inflation differentials. In order to be able to offset impacts of a shock sound government finances are necessary to prevent excessive deficits. This requires public sector to generate surpluses in time of economic boom to pay back the deficits made during the recessions. The Stability and Growth Pack was introduced to secure that financial condition of member states of Euro zone remain stable, problematic is putting it to use as in the past some countries didn't abide by the rules set in this pack and found out there was no punishment, the enforcement of Stability and Growth Pack is therefore problematic. Problems arising from inflation differentials could be therefore mitigated by common fiscal policy, which the European Monetary Union lacks.

Another argument that could be raised is that inflation and interest rate differentials are present in every country or a region that uses one currency. For example an empirical study carried by Darvas and Wolff (2014) showed that these differentials are present apart from European Monetary Union in Australia, Canada, Japan and the USA. They argue that these differentials could be found in every country if inflation would be measured with respect to every county/region/district and subsequently compared to the level of the whole country. This point of view implies that inflation and interest rate differentials are not rare and also are not a phenomenon of recent period but were always present and as such are a natural part of functioning of single currency areas.

2 Inflation and interest rate differentials – empirical analysis

In the current literature inflation and interest rate differentials within a single currency area are calculated in two ways. One way is to calculate them as a difference between each member state's inflation and the inflation rate of the whole area (represented by average or weighted average of inflation rates of all regions/districts of a monetary union). This methodology was used for example in Darvas and Wolff (2014) or Honohan and Lane (2003). Other way is to compare it to one country of the region (e.g. Germany in EMU) such that each state's inflation rate is subtracted from the inflation rate of this chosen state. The latter methodology is often used in papers concerning European Monetary Union; it was used for example by Favero (2011). Both techniques are used in this paper as each one has some benefits and negatives. The robustness of analysis in this paper is therefore increased compared to previous analyses. Comparison of results obtained by using both techniques is included as well, which was not performed in previous analyses and brings another contribution. Calculation of the inflation differentials with respect to one of the states of region in question is suitable for analysis of given region but does not enable comparison between the regions. For the purpose of comparison usage of average rate of the whole single currency area is more suitable.

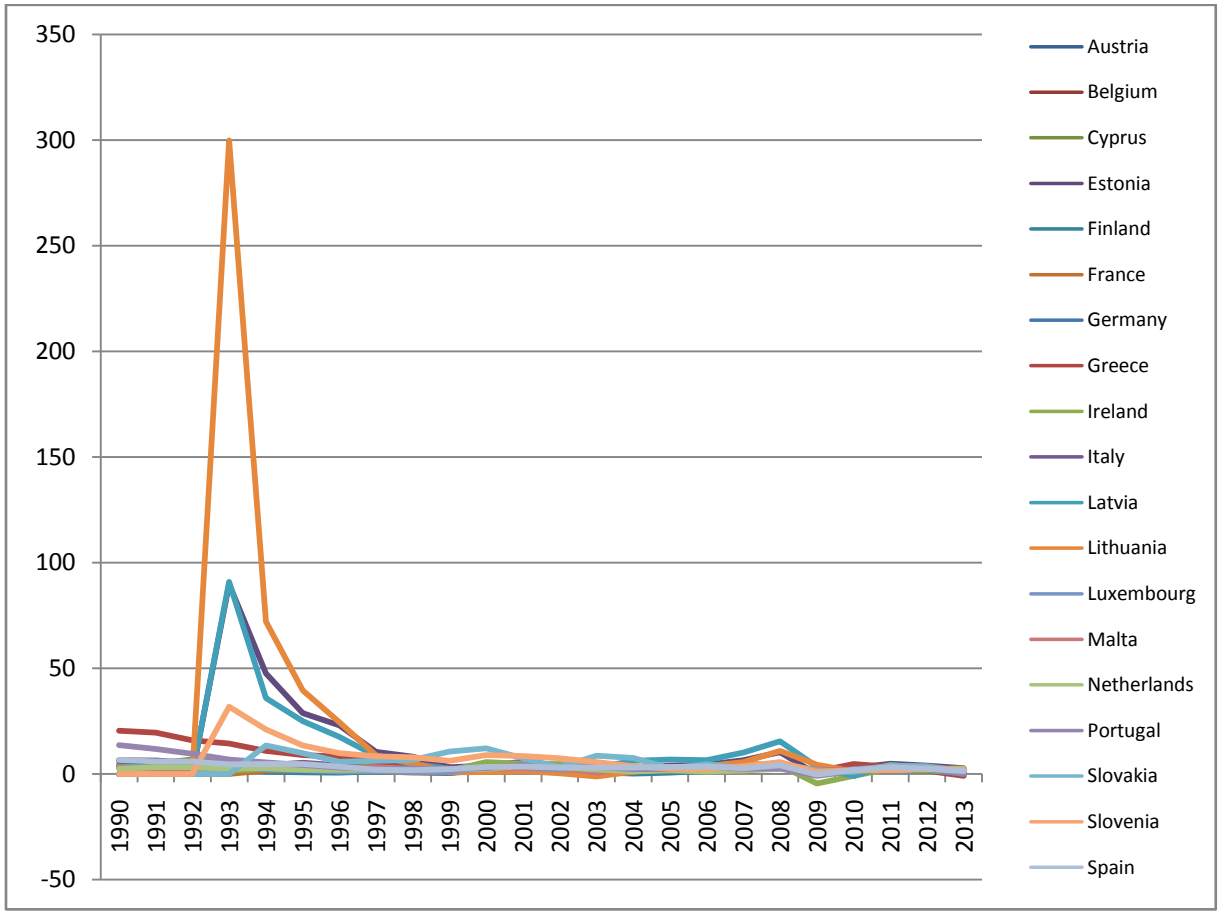
Real interest rates differentials are calculated very similarly. Yields on long term (10 year) government bonds are used as country's interest rate; base for calculation of interest rate differentials is usually twofold just as in case of inflation differentials, it is either inflation rate of one region within the single currency area or weighted average of interest rates of the whole region.

2.1 Analysis of inflation and interest rates within European Monetary Union (EMU)

2.1.1 Inflation

Source of EMU inflation rates used in this paper is UNCTADStat in time series from 1990 to 2013[2] (UNCTADStat). Graph 1 below shows the historic rates of EMU 19 member states inflation rates.

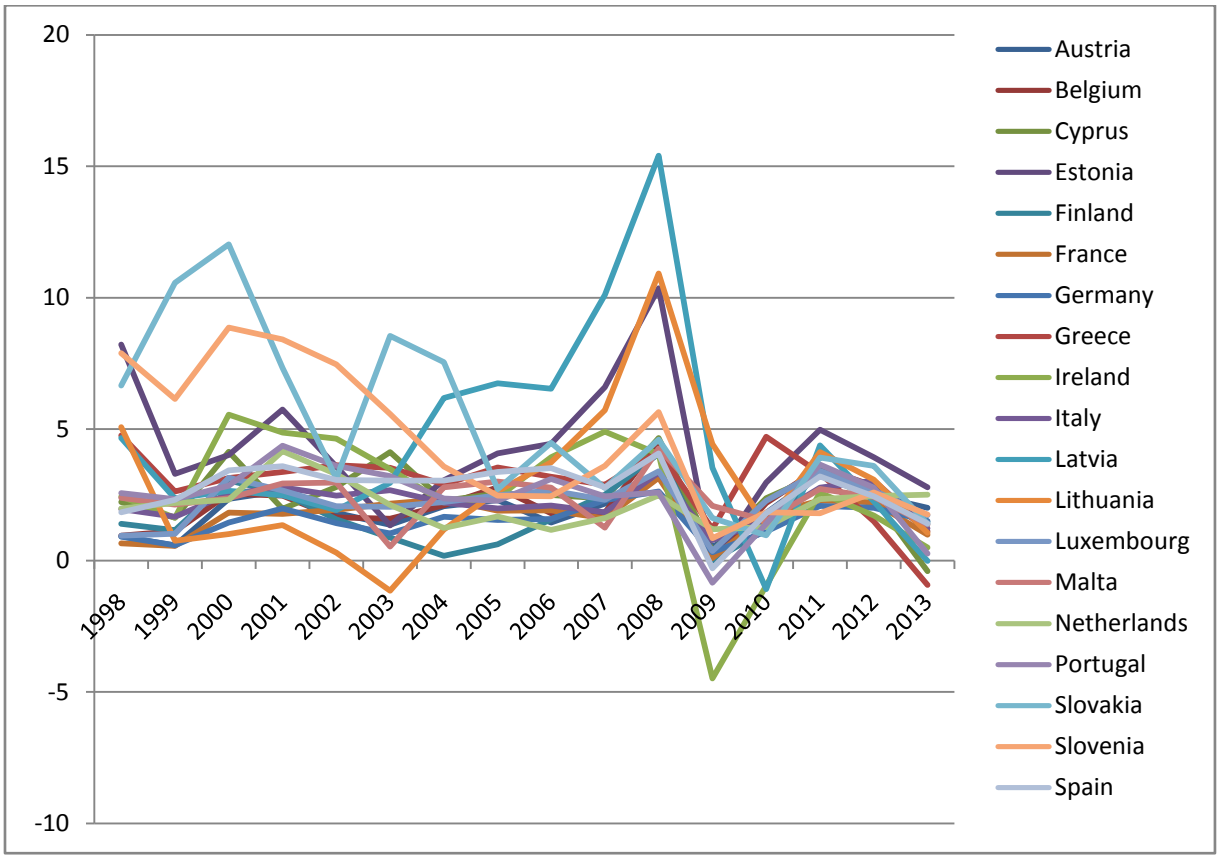
Graph 1: Inflation in EMU 19 (1990-2013) in %



In the beginning of 1990's inflation rates of today's EMU 19 countries were not stable. Most extreme rates were in Lithuania, Latvia, Estonia and Slovenia. Other states experiences only mild inflation. To demonstrate differences in inflation rate between the states more precisely, the time period is shortened only from 1998 to 2013 in the Graph 2.

[2] The time period includes years before the existence of European Monetary Union, which was established in 1998. Pre-EMU years are included as the data from this period will be used later in the paper for comparison of EMU and the USA

Graph 2: Inflation in EMU 19 (1998-2013) in %

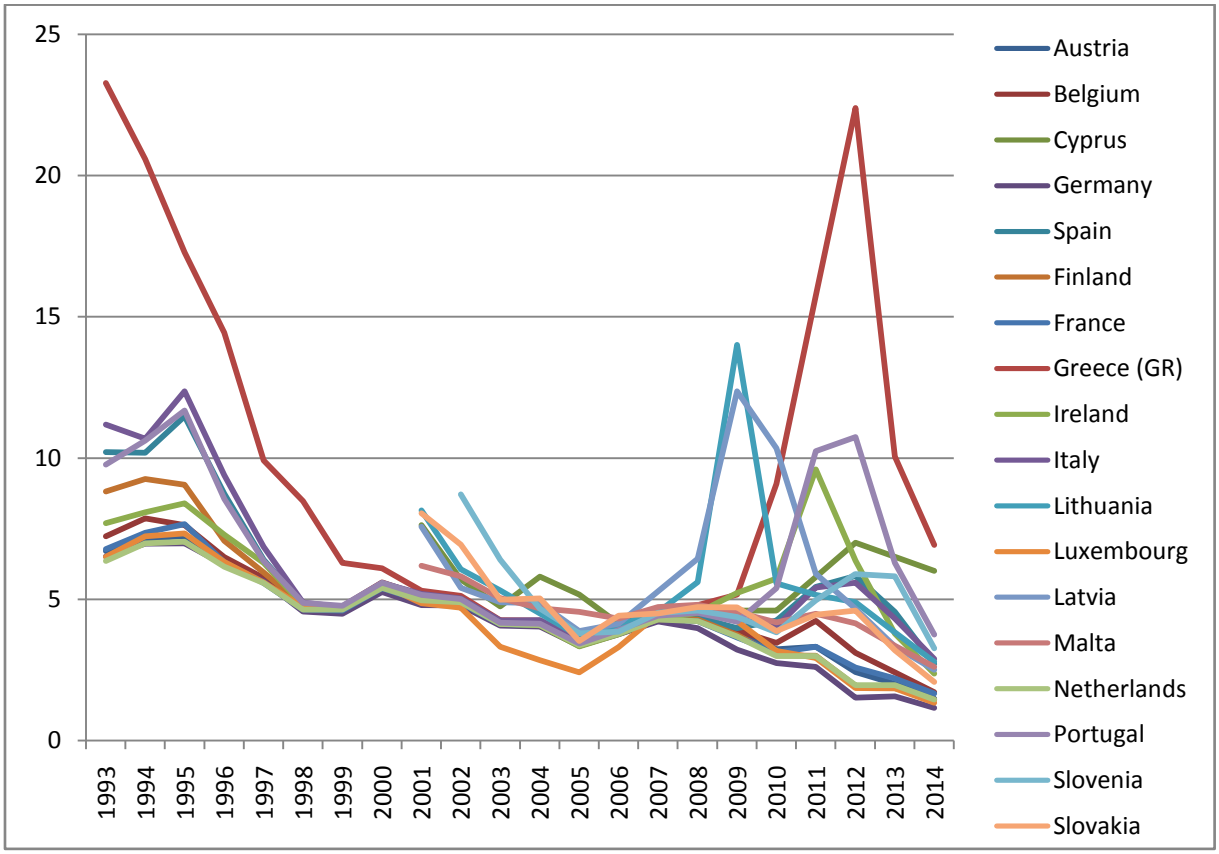


A brief look at Graph 2 showing inflation at percentage point levels indicates that inflation rates are not the same in the EMU 19. In the period of 1998 to 2008 it cannot be definitely concluded from this graph whether inflation rates of EMU 19 countries were converging or diverging. The 2008 financial crises caused increase in inflation of all countries EMU 19 and also an increase in the variability of inflation rates. In the period of 2008 and 2011 inflation rates experienced a U-shaped evolution and since 2011 they seem to stabilize with downward movement trend and lower variability than in the pre-crises period. A prediction of high inflation rate differentials in year 2008 and of low inflation differential in 2011 to 2013 period can be made. This prediction will be checked by calculation of inflation differentials in chapter 2.2.

2.1.2 Interest rates

Source of government bond yields that will be used for construction of interest rates differentials used in this paper is European Central Bank. Graph 3 describes the evolution of EMU19's interest rates (Spain excluded)

Graph 3: EMU19 interest rates (1993-2014) in %



Graph 3 illustrates that during 1990's interest rates converged. From 2000 to 2008 interest rates of today's EMU 19 countries were moving alongside each other despite the fact that Eurozone grew significantly in the number of its members during this period. The financial crises of 2008 and the debt crisis in the following years caused divergence in interest rates of EMU members. Countries that were hit most severely by the sovereign debt crises (Greece, Portugal, Ireland, Cyprus) are the countries with the highest values of interest rates in the period of 2010 and 2012. After year 2012, interest rates seem to be converging again. The reason why this happens in year 2012 is attributed in great part to Mario Draghi, the president of European Central Bank, who announces a fight of ECB against too high yields: *"To the extent that the size of these sovereign premia hamper the functioning of the monetary*

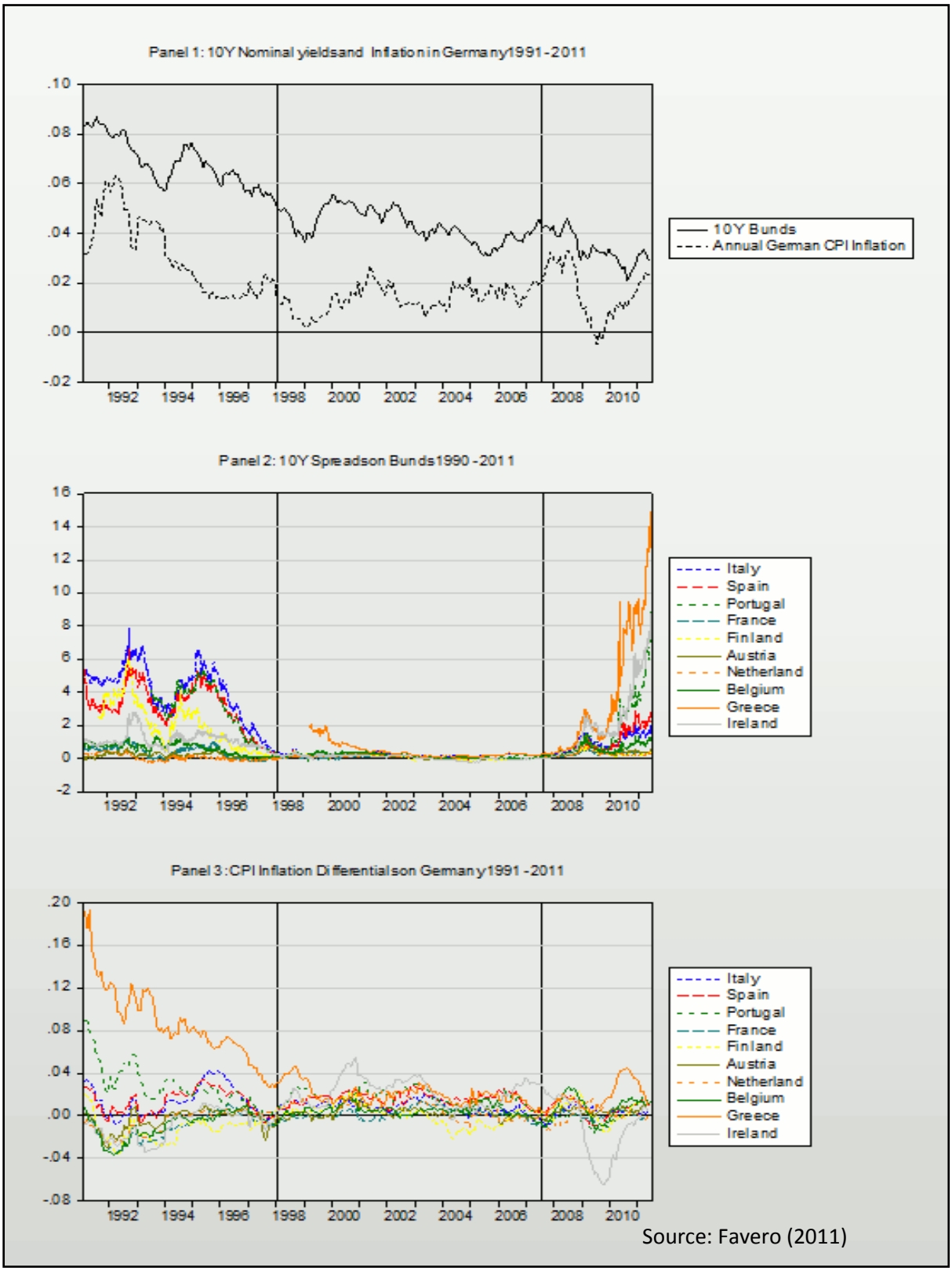
policy transmission channel, they come within our mandate." "Within our mandate, the ECB is ready to do whatever it takes to preserve the euro." He also added: *"Believe me, it will be enough."* (Bloomberg 2012) Market participants believed the commitment of ECB and bet on sinking yields. As a result yields really decreased.

Real interest rate differentials will be influenced by this historic development, prediction of very similar development of real interest rate differential can be made. These conclusions will be further analyzed in more details in the next section describing interest rate differentials.

2.2 Analysis of inflation and interest rates differentials within European Monetary Union

In case of EMU calculation of inflation differentials by applying German inflation as a central rate is reasonable as Germany is regarded as the biggest economy in EMU 19 and whole European Union and also the most stable one. As was already mentioned in the introduction of this chapter this kind of model is typically used when assessing European Monetary Union. Most of the recent analyses are still carried out in the crisis period. They show that there is the divergence in the inflation and interest rates in the European Monetary Union and as a result they often question the future of its common currency. However, these analyses are carried out in turbulent years and cannot distinguish whether the divergence is a short time phenomenon connected directly with the financial crisis or whether the divergence will continue in the after-crises years. Historic development of inflation and interest rate differentials resulting from these analyses can be summarized in three periods, which are illustrated by the Graph 4.

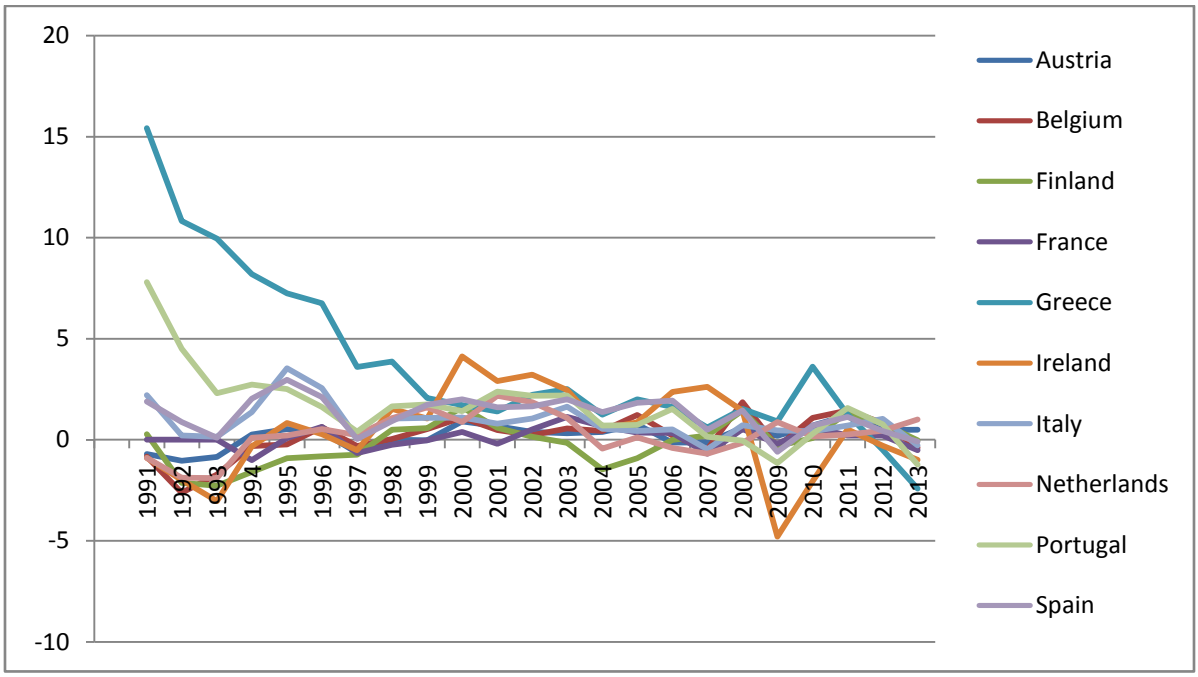
Graph 4: Nominal yields and inflation in Germany, spreads on bunds and CPI inflation differentiation on Germany



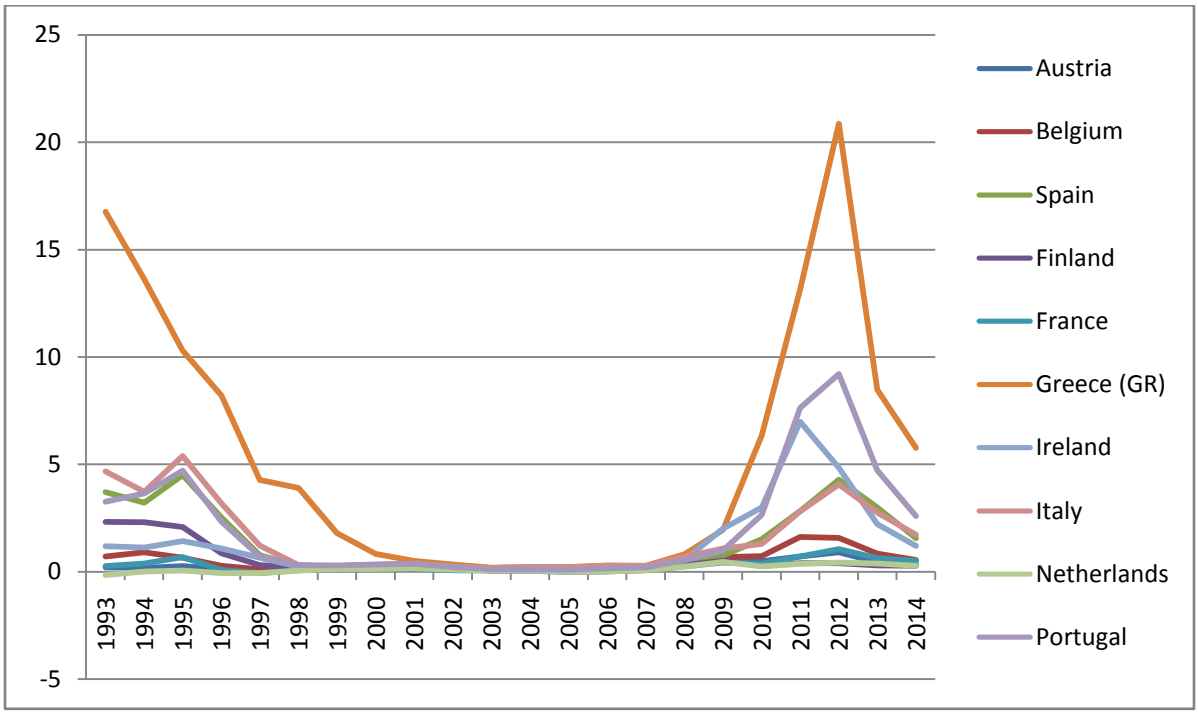
Source: Favero (2011)

As was mentioned, three periods of the development of the differentials in the EMU were identified. First one is a pre-EMU period (before 1998) when interest rates differentials reflected different inflation in each country resulting in different exchange rate fluctuations. Second period, marked by the introduction of new common currency – the euro, between 1998 and 2008 is specific by converging of both interest and inflation rates and the third period which started in 2008 and which is specific by divergence of interest rates while inflation rate differentials remain negligible. This specific analysis (Favero 2011) could use dataset only till 2011 when differentials were increasing and it did not look well for the future of the euro zone, as a result sustainability of euro area was questioned. It is therefore important to look how the differentials have evolved in the following years. Graphs 5 and 6 below show the remodeled time series including another two years till 2013.

Graph 5: Inflation differentials in EMU 10, compared to Germany (%)



Graph 6: Interest rates differentials in EMU 10, compared to Germany (%)



The Graph 5 confirms results of previous analyses presented in Graph 4 concerning inflation differentials. It also shows that in two additional years (2011-2013) the trend of inflation differentials in EMU10 did not change. Graph 4 also described development of interest rate differentials in EMU10, which showed clearly three periods. Graph 6 acknowledges these results and adds another observation. In addition to already observed three periods another one can be distinguished. A fourth period starting in 2012 and continuing till present when interest rates are converging again, with the exception of Greece, can be added. This result changes grim lookout of analyses conducted in previous years for the future of EMU to more positive, as it shows that divergence in interest rate differentials was only a short term problem of after crises period and the fact that these differentials are converging again.

2.3 Comparison of EMU and USA

In the previous section it was found out that there are inflation and interest rate differentials in European Monetary Union. Their presence is not surprising and rather expected as was argued in the theory part of this paper. Even though real interest rate differentials are decreasing and inflation differentials are stable, this fact does not say whether

these differentials are too sizable or whether their magnitude is negligible. There is currently little theoretical background of stating the adequate maximum magnitude of inflation and interest rate differentials. Even though some maximum values are suggested in the literature, for example 1 percentage point in (Angeloni and Ehrman, 2004), it can be used only as a rule of thumb as these theories have not been found very convincing. The best way to deal with this problem is to compare the differentials in EMU to similar entity. Suitable entity to compare EMU to are the United States of America (USA) as they are closest in their structure and position in the world economy to EMU. They are also composed of many smaller states, represent large share of overall world's gross domestic product and they have common monetary policy. There are also many differences, for example USA has common both monetary and fiscal policy, it has much better labour mobility and the integrity of USA is not doubted as in case of EMU. These differences do not make the comparison of inflation and real interest rate differentials impossible; however, it is necessary to mention the fact that the direct comparison of these two single currency areas will have its limitations.

2.3.1 Methodology

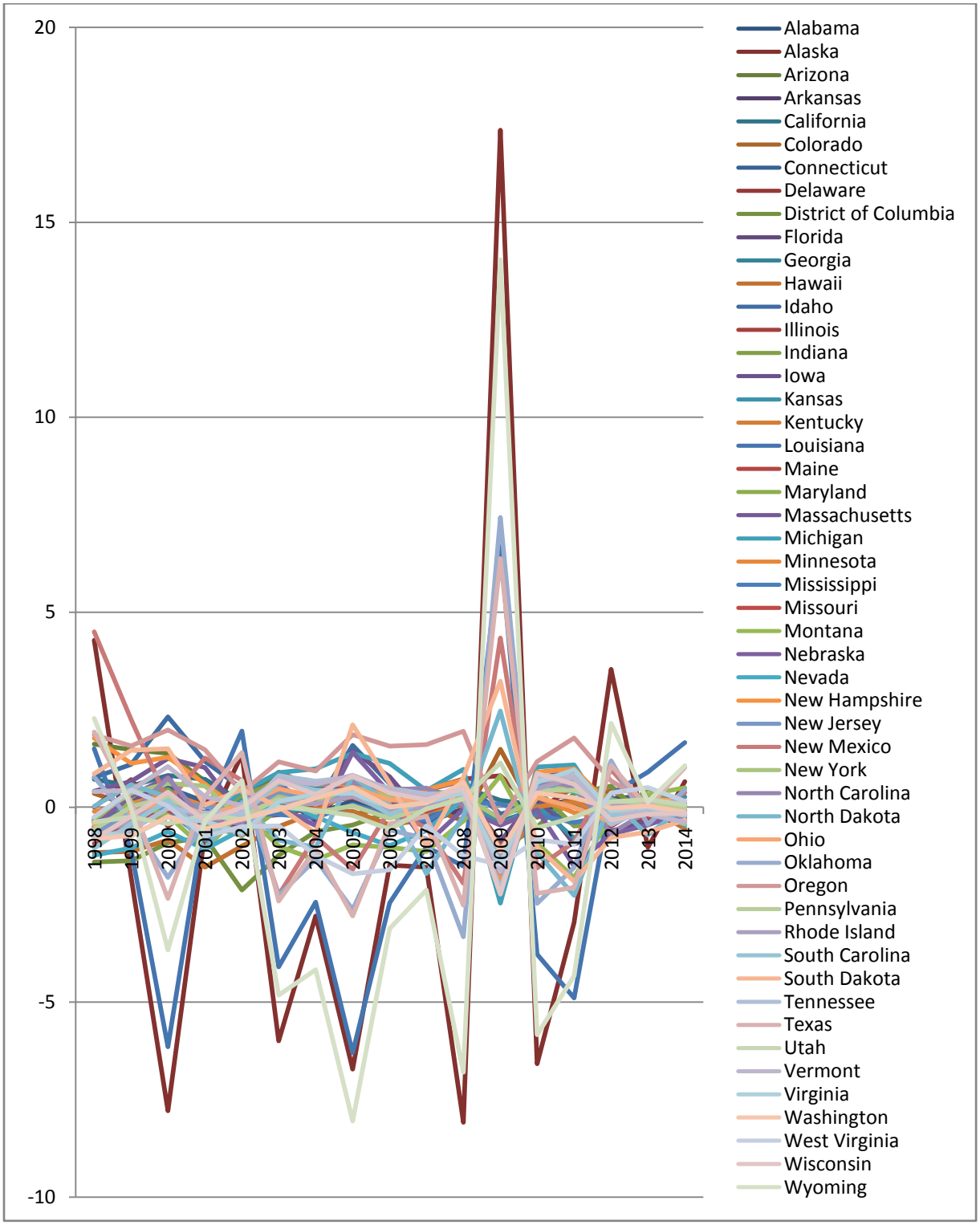
To be able to compare differential in USA and European Monetary Union, the same way of their calculation must be used in both regions. Calculation of inflation differential for EMU was quite straightforward, as it is possible to obtain the data for inflation for each member country. Inflation differential was calculated as a subtraction of inflation in given country and Germany, which was used as a base for all calculations. On the other hand, the data on inflation rates is not available for each state of the United States of America, which makes calculation of inflation differentials more complicated. But it is possible to obtain the data on nominal and real gross state product (GSP) of each state of the United States of America (U.S Bureau of Economic Analysis, 2015). From these two measures, inflation differentials can be obtained.

From real and nominal GSP a regional GSP-deflator can be derived. GSP-deflator is calculated as nominal GSP divided by real GSP. Regional inflation rate is computed as the first difference of the logarithm of the regional GSP-deflator. A region's inflation differential with the rest of the US is then calculated as a difference of region's inflation rate and inflation rate of USA (calculated by deflator from the GDP of US). Real interest rate differentials of each state of the USA are calculated as a difference of 10-year government bond yield and a regional inflation rate of a particular state.

2.3.2 Inflation differentials in USA

Graph 7 below shows the graphical interpretation of inflation differentials in USA calculated according to methodology described in previous chapter.

Graph 7: Inflation differentials in USA (%)

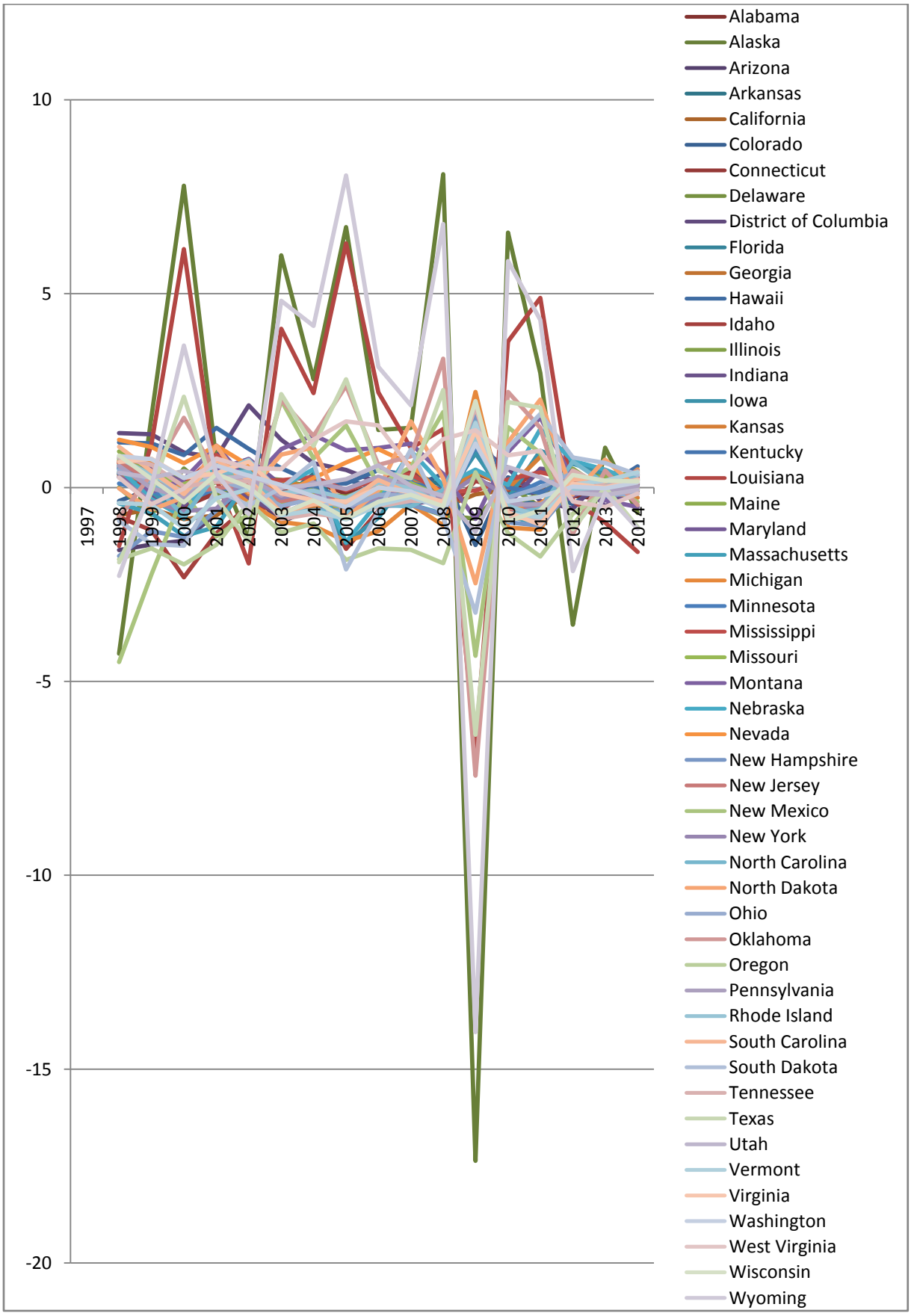


Graph 7 shows that inflation rates are not the same even among the USA states. Before the 2008 financial crises, inflation rates of particular USA states different from the average by two or three percentage points were not rare, with local extremes in several years (2000,2003,2005,2008) being different from the average by approximately seven percentage points. The effects of the crises took place in year 2009, when the most extreme value of inflation differential reached seventeen percentage points. Even in the after-crises years inflation differentials of approximately two percentage points were not rare.

2.3.3 Real interest rate differentials in the USA

Calculated regional inflation rate is further used for formation of real interest rate differentials. The regional real interest rate is the difference between the average nominal interest rate on ten-year Treasury bills and regional inflation rated in US (in EMU as a difference between ten-year government bond rate of a given state and its inflation rate). Since the nominal interest rate inside a monetary union is same for each region, the regional real interest differential has to be the same as negative value of regional inflation differential (Arnold and Kool, 2003). Graph 8 presents interest rate differentials in USA and confirms the fact that their value equals to minus inflation differentials when comparing the same years. This feature is not present in EMU as each member country of the euro zone issues its own bonds with different nominal interest rates.

Graph 8: Interest rate differentials in USA (%)

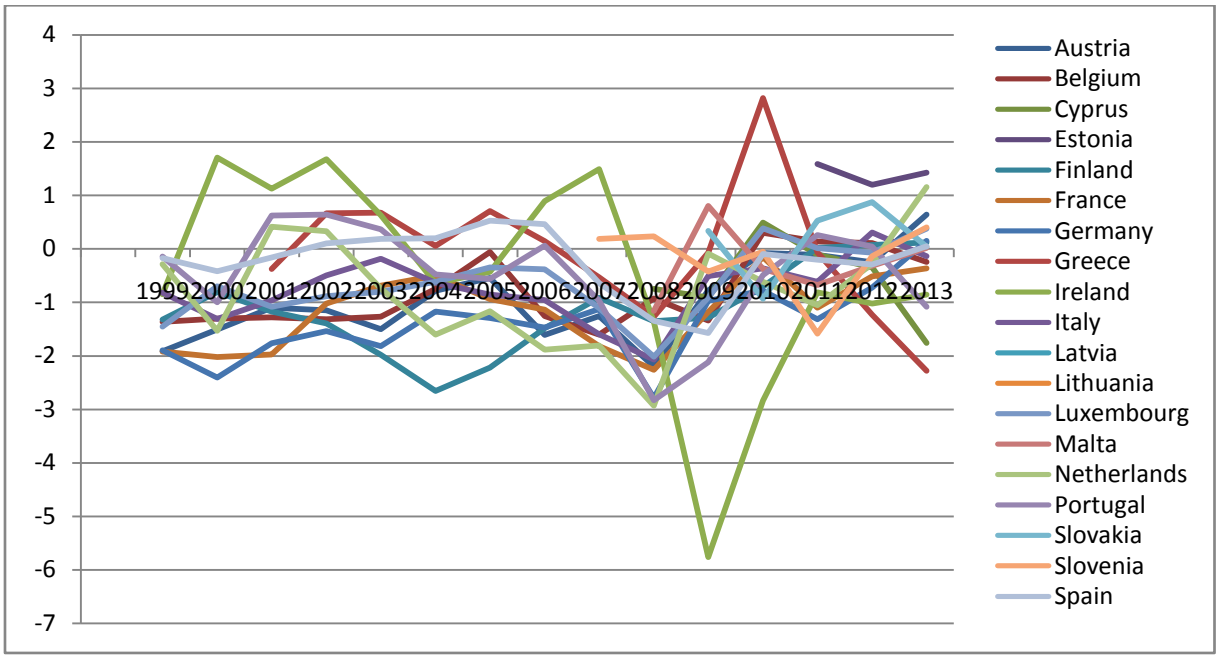


Since the real interest rate differentials equal minus the value of inflation differentials the resulting comments on real interest differentials will be the same as in case of inflation differentials. Graph 8 shows the same patterns as Graph 7, maximum values of differentials were in 2009, minority of regions reached substantial differentials of approximately seven percentage points throughout the whole period and majority of regions kept the differentials of up to three percentage points during the observed period.

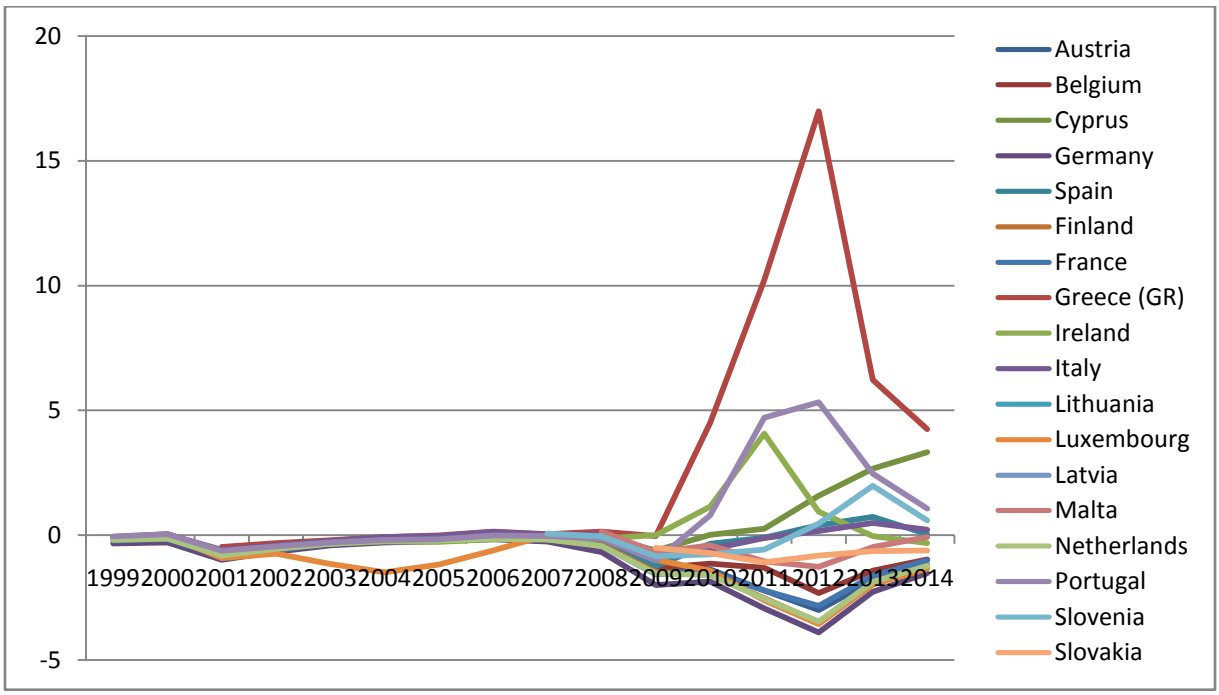
2.3.4 Methodology adjustment for EMU data and average differentials

Analysis of inflation and real interest rate differentials in the euro zone in section 2.2 did not include all countries of EMU. It was conducted on the countries that joined EMU before 2002 as these countries were well established and had enough time to accustom to the new currency. These countries were also chosen in analyses that were carried out in recent years and on which was based the addition of the fourth period of interest rate differentials historic development in section 2.2. Results of analyses of this sample describe very well the effects of the crises on the countries well established within monetary union, but it does not reflect the situation of current EMU, as it omits nine countries. As a goal of this paper is to analyze the EMU as a whole, remaining countries are analyzed as well in further discussion. Graph 9 and Graph 10 below show inflation differentials and interest rate differentials respectively of all EMU countries. Each country is included to the dataset according to the year of its entry to EMU. Not only dataset is adjusted, the methodology of establishing the differentials is different as well. In order to keep the results of both regions comparable, inflation differentials of EMU must be calculated in the same way as those of USA. Inflation and interest rate differentials of EMU calculated with respect Germany in chapter 2.2 are therefore recalculated again according to methodology used for USA. Inflation in each member state of EMU is therefore calculated by using GDP deflator, instead of using the data on inflation from UNCTADStat. Germany is no longer used as a basis for calculation of differentials; weighted average of inflation and interest rates is used instead. Weights are represented by GDP of each European country.

Graph 9: Inflation differentials of EMU 19 (%)



Graph 10: Interest rate differentials in EMU 19 (%)



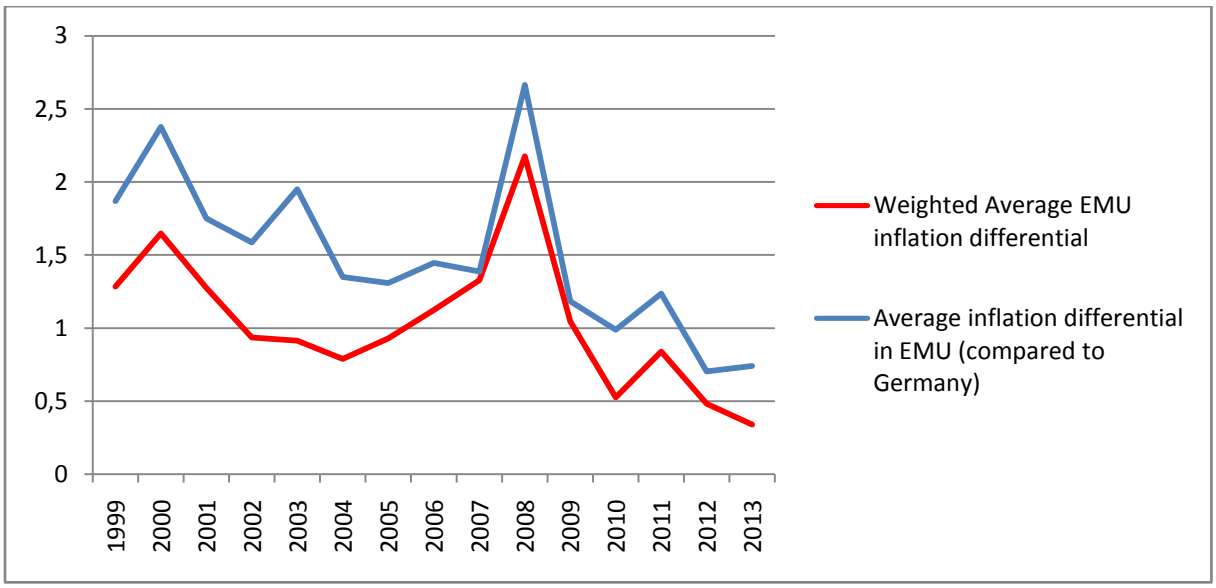
Graph 9 shows that even when all member states are included to the dataset and the methodology is adjusted, conclusions that were made for inflation differentials in section 2.2 do not change. Newly joint countries are not susceptible to volatility of prices after the crises. Latvia and Lithuania are not included since they became members of EMU after 2013.

Previous conclusions made from analysis of real interest rate differentials of EMU 10 are not affected by adding the rest of member countries as well as is illustrated by Graph 10.

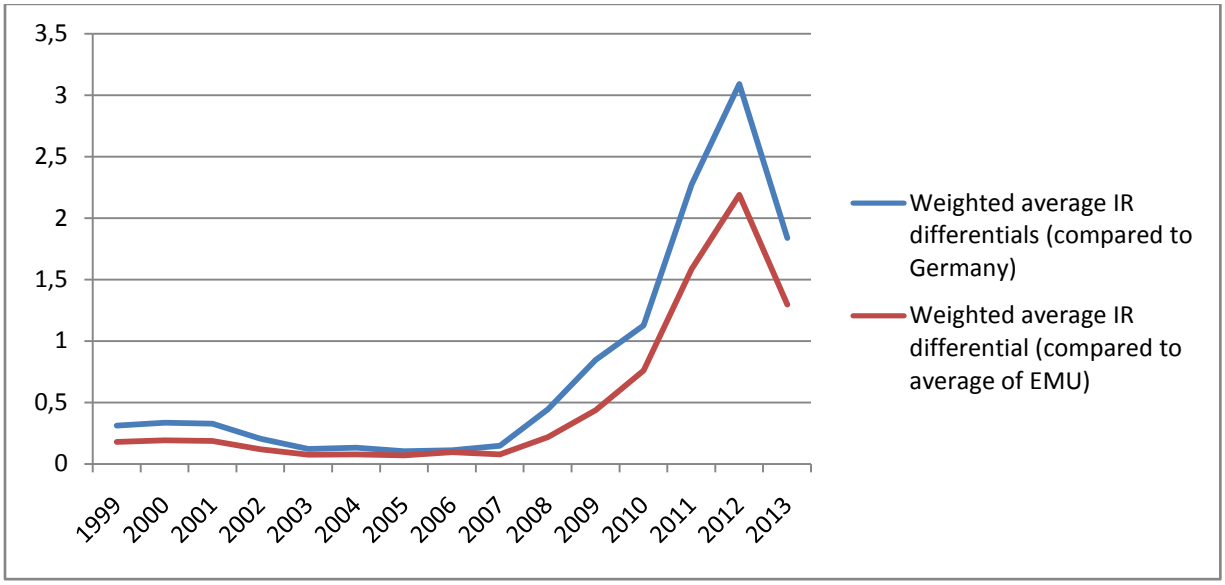
To enable more precise comparison of both inflation and interest rate differentials in EMU, average differentials are introduced. This measure is used to incorporate all countries of EMU in only one variable, meaning that comparing two methodologies can be done by looking at only two curves on a graph. It is calculated as weighted average of absolute values of inflation or real interest rate differentials where GDP is used as a weight. As such it is always a positive number, it does not say whether overall differential is bigger or smaller than the average, it just describes the distance between the aggregate differential and the average.

Graph 11 below shows resulting weighted average inflation differentials calculated in relation to EMU average inflation rate in comparison with the previous methodology where Germany was used as a base. Graph 12 illustrates comparison of the two methodologies on average interest rate differentials

Graph 11: Weighted average inflation differential in EMU19 - comparison of methodologies (%)



Graph 12: Average real interest rate differentials in EMU - comparison of methodologies (%)



Graph 11 shows that the trends of average inflation differentials in EMU are almost the same when either methodology is used, only magnitude of differentials changes. The coefficient of determination of regression of the two sets is 0.809 which shows that these two methodologies produce very similar results. For regression output see Appendix 1. Graph 12 compares the results of average real interest rate differentials when both methodologies are applied. It also illustrates the fact that the results of each method of calculation are very similar. The coefficient of determination is also calculated and equals to 0.996 which shows that these methodologies produce almost identical results. For regression output see Appendix 2.

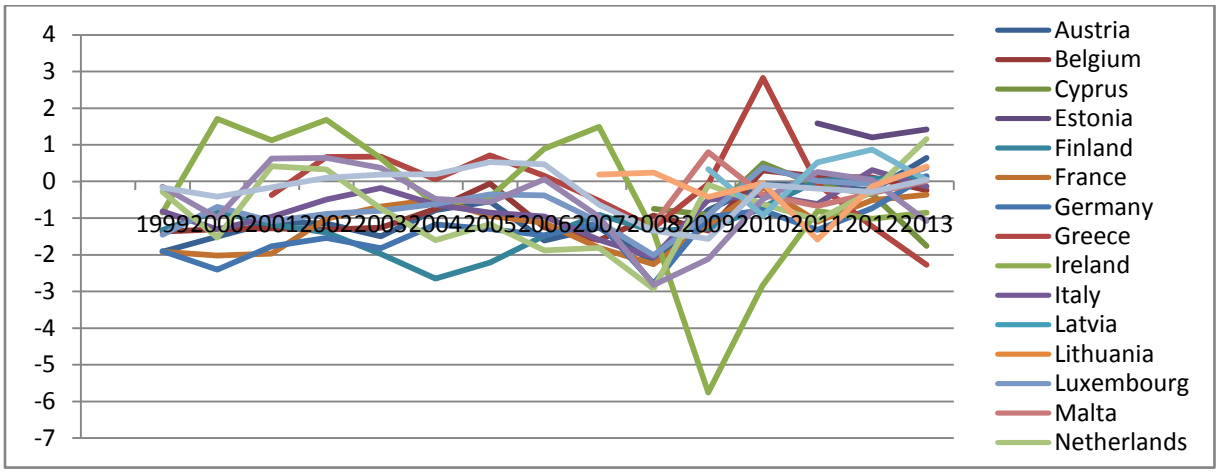
Since the methodologies of calculation of inflation and interest rate differentials are united in both regions the differentials in EMU and USA can be compared directly.

2.3.5 Comparison of EMU and USA

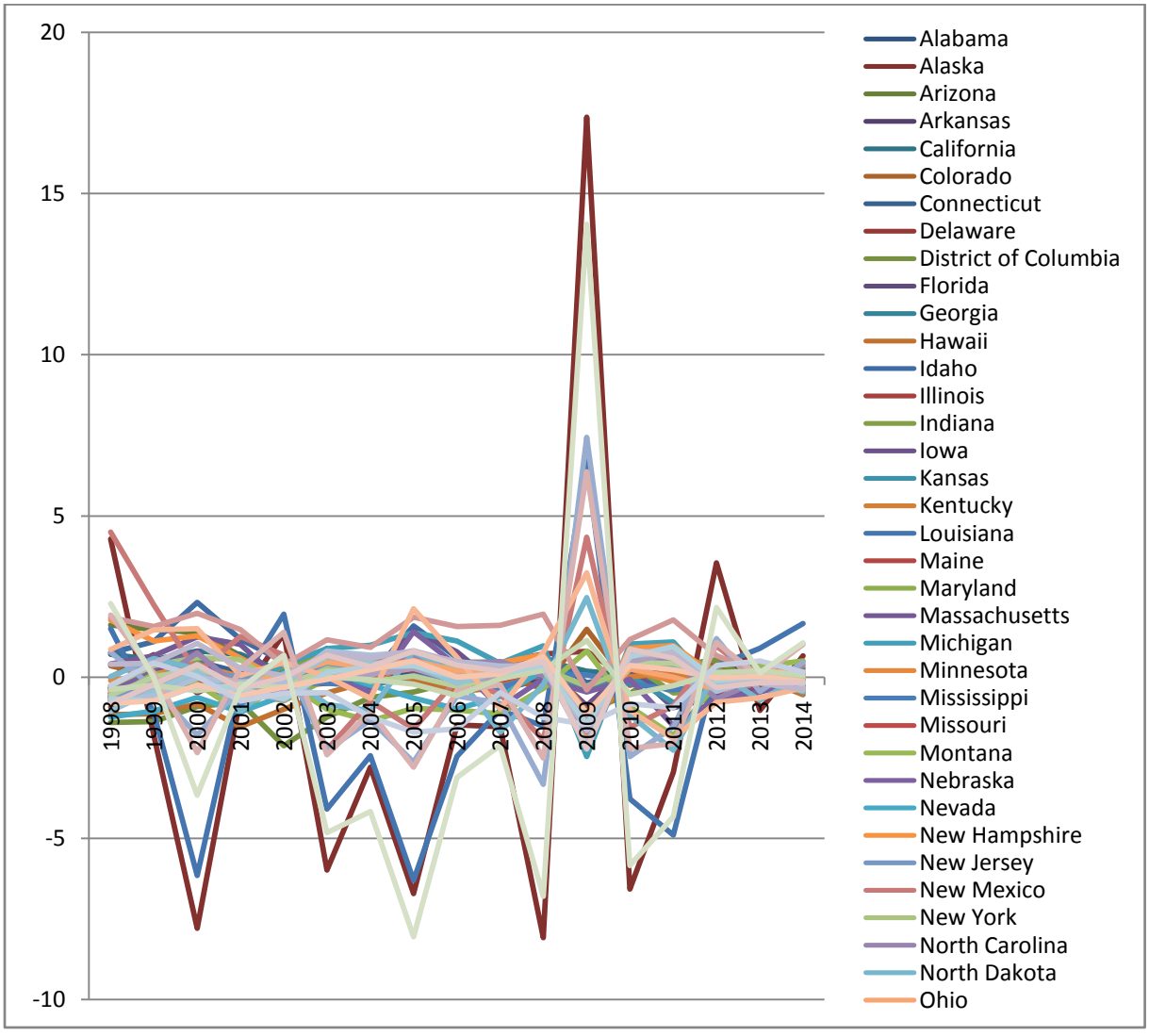
2.3.5.1 Inflation rate differentials

In a first step, we compare the inflation differentials in both single currency areas graphically. Graphs below are Graph 9 and Graph 7, which described inflation differentials in EMU and USA, only put on next to each other to simplify comparison.

Graph 9: Inflation differentials of EMU 19 (%)



Graph 7: Inflation differentials in USA (%)



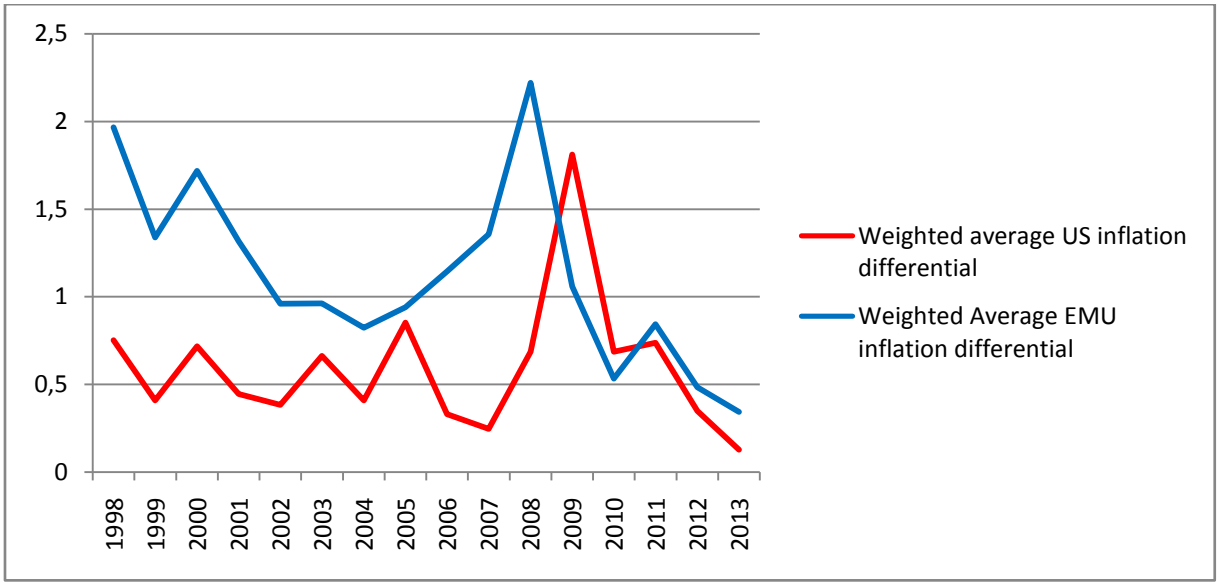
Most projecting difference between the two regions is that in EMU there were not so extreme changes in inflation differential patterns after the start of the financial crises. Overall volatility of inflation differentials during the whole period also seems to be smaller in EMU than in the USA. A quick look at these two graphs suggests that EMU might have lower inflation differentials. This quick graphical analysis can be deceiving, as a few extreme values might make the whole single currency area look worse. To avoid this mistake, analyses of average inflation differentials is included as well.

Analysis of average differentials enables much more precise comparison of the EMU and USA just as it helped to compare the methodologies of calculation of differentials of EMU. Their formation is the same, see page 28 for reference. Comparison of average inflation rate differentials in EMU and the USA in Graph 13 displays some differences between the two regions. Firstly, pre-crises inflation differentials were on average higher in EMU. This situation changed during the crisis as in years 2009 and 2010 average inflation differential was lower in EMU. This position switched again in 2011 when average inflation differential of the USA decreased under the level of EMU's average differential. Even though the USA has lower average inflation differential, EMU got much closer to the value of average inflation differential of the USA in the after-crises period and it became smaller than in the pre-crises period. The values of average inflation differentials of both regions do not differ significantly at the end of observed period.

Secondly, peak values of inflation differentials were higher in EMU than in the USA. This fact may show that the financial crisis may had more profound effect on the divergence in EMU and that it is more susceptible to the sudden changes in financial markets. On the other hand, taking into consideration that before the crisis average inflation differential was approximately one percentage point, the peak value was 1.2 percentage points higher than before the crisis. If we conduct similar comparison for average inflation differentials in USA, we find out that from approximately 0.5 percentage points, differential rose on average by 1.2 percentage points as well, as the peak is at approximately 1.7 percentage points. This analysis shows that the reaction to financial crisis in terms of change of magnitude of inflation differentials was almost the same in both regions.

Thirdly, peak value was reached one year earlier in EMU than in the USA, the value of average inflation differentials started to rise sooner in EMU as well. This shows that the external shock was absorbed faster in the EMU

Graph 13: Comparison of average inflation differentials in EMU and USA (%)



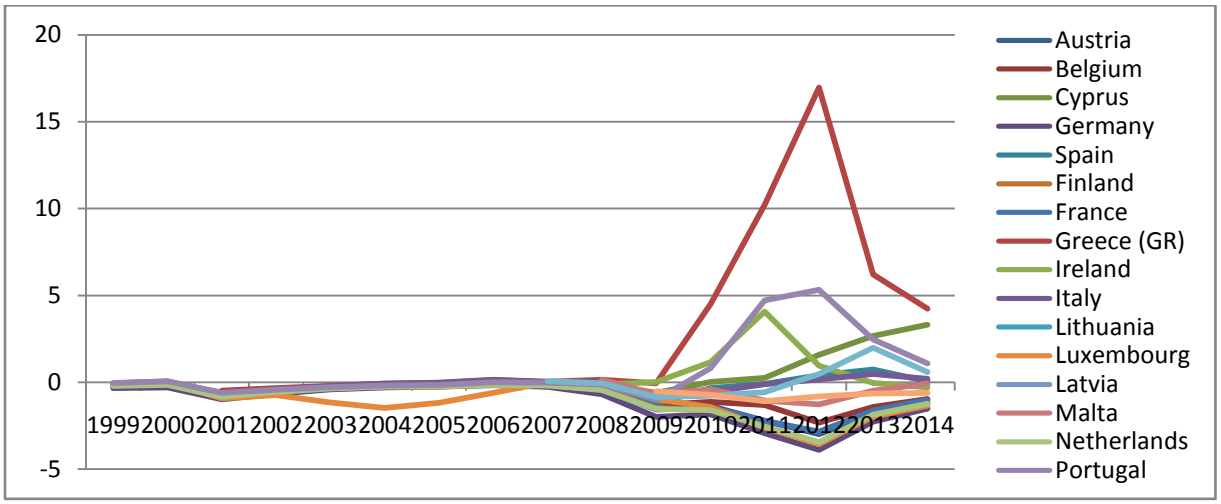
The two-tail difference means test was carried out to evaluate statistically whether the inflation differentials are similar in both USA and EMU. The null hypothesis of the test is that the difference of the means of inflation differentials in EMU and USA between 2002 and 2013 equals zero. On five per cent significance level the null hypothesis is not rejected as the resulting p-value equals to 0.0669. See Appendix 3 for the full report of the two sample t-test carried out in Microsoft Excel. Based on these results, Inflation differentials were therefore similar in both regions in this time period.

To sum up the results of comparison of inflation differentials in the USA and EMU, EMU does not have significantly higher inflation differentials than USA. Inflation differentials should not form an obstacle in the future of the Euro area. Above mentioned analyses showed that inflation differentials are gradually decreasing in EMU and 2008 crises did not cause in comparison to USA extreme increase in inflation differentials. The similarity of inflation differentials of both regions was also verified by difference means test.

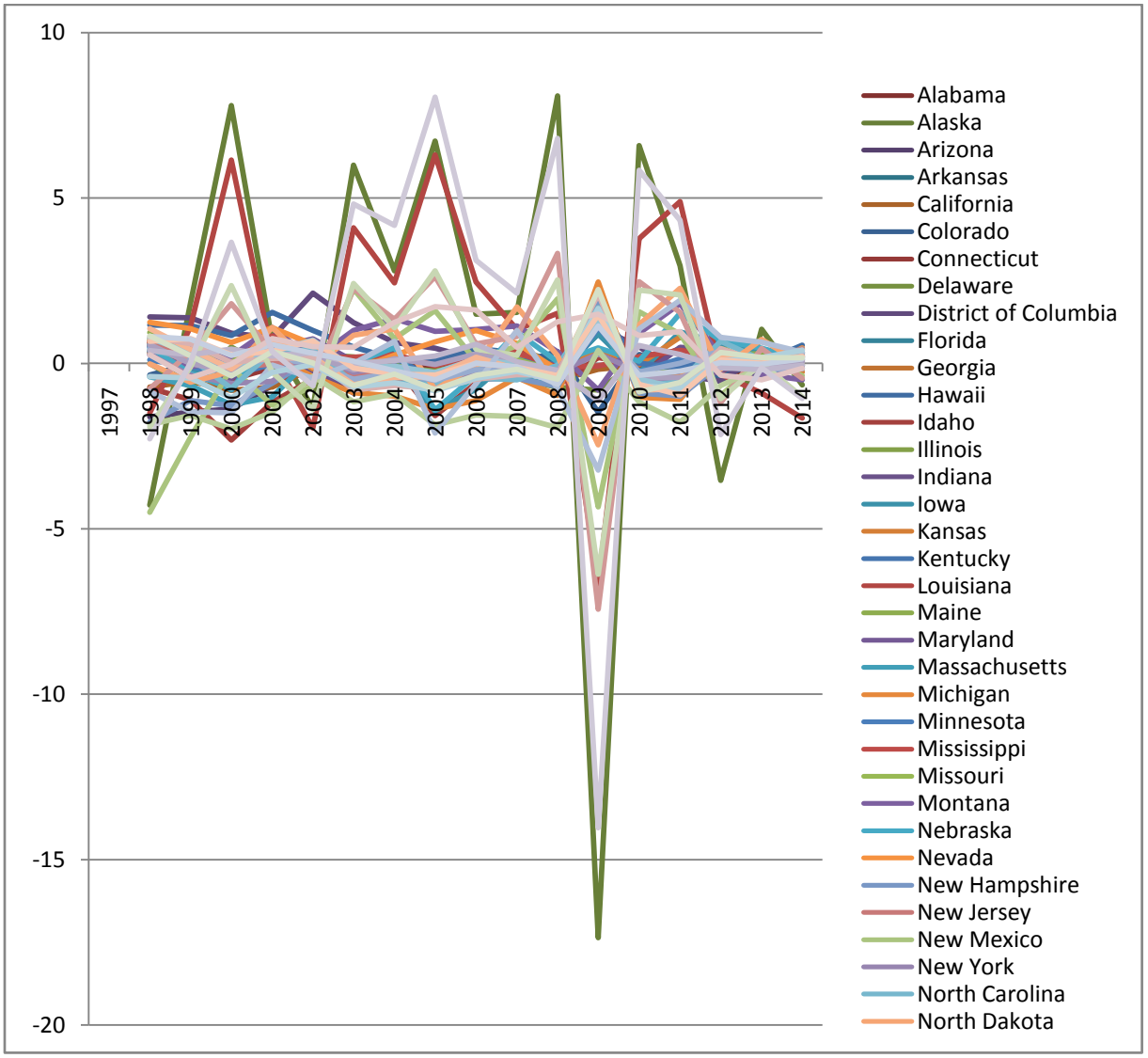
2.3.5.2 Real interest rate differentials

To compare real interest rate differentials of both regions, Graphs 10 and 8 are reintroduced below.

Graph 10: Interest rate differentials in EMU 19



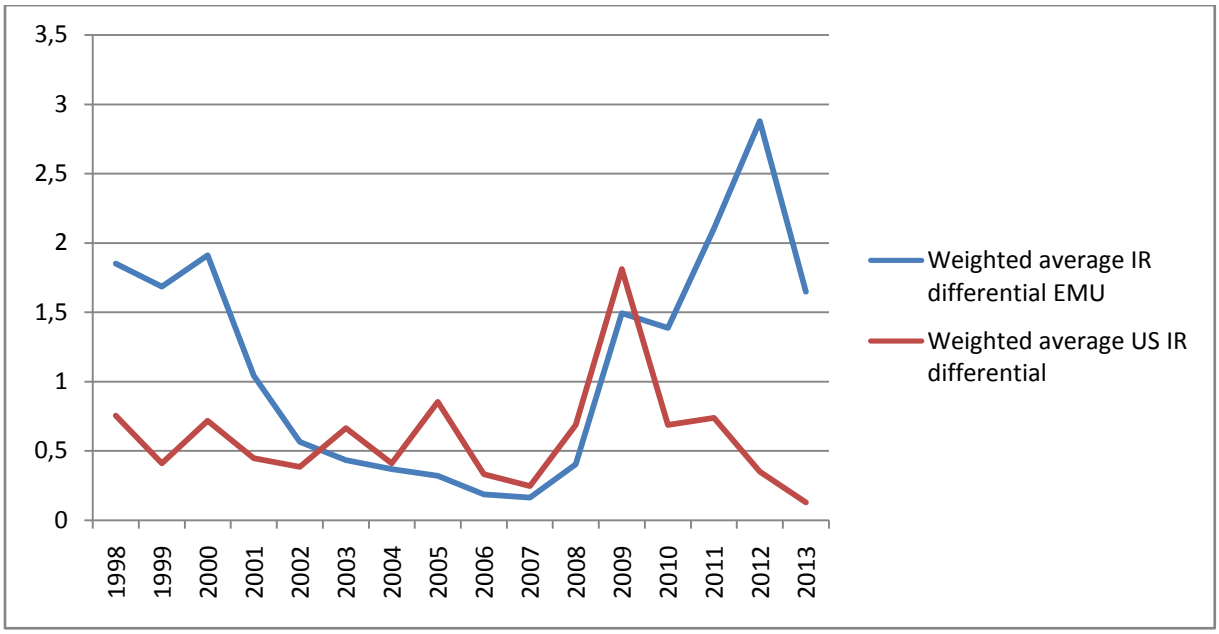
Graph 8: Interest rate differentials in USA (%)



First look at Graphs 10 and 8 tells that they do not share many similarities. Real interest rate differentials before the financial crises were more volatile in the USA and they also reached higher values in this region. The 2008 crises caused sudden increase in real interest differentials of USA states in 2009 and their immediate fall in the following year, while the financial crises caused a start of mild increase in real interest rate differentials in EMU that continued for following four years, resulting in peak values in 2012. This development is connected with the sovereign debt crisis in the countries of EMU and consequent "flight to quality." As the returns on investment in government bonds in peripheral countries (GIIPS countries) became less safe with increasing level of sovereign debt, investors moved their funds to the core states of EMU (Germany, Netherlands). This flow of capital caused further increase of interest rates in peripheries and a decrease of interest rates in the core countries, which resulted in increasing discrepancies and interest rate differentials. As was already mentioned in section 2.1.2 the end of this process occurred in 2012 when ECB announced the fight against increasing differentials and its willingness to intervene in bonds market to secure the euro. Unlike the USA real interest differentials the EMUs differentials were negligible before the crises.

Following graph (Graph 14) illustrating average real interest rate differentials of both countries enables much more precise comparison.

Graph 14: Comparison of US and EMU weighted average real interest rate differentials (%)



Graph 14 shows that real interest rate differentials in both regions had different historic developments. The size of the differentials was smaller in EMU during the period between 2003 and 2009. The 2008 financial crises triggered increase in differentials in both regions and their magnitudes were increasing until 2009. The difference is that in USA real interest rate differentials were decreasing since 2009 while in EMU, they decreased only in the following year (2010) and started to increase again till 2012, when they reached their maximum value. This development corresponds to the fact that in 2010 sovereign debt crisis, which caused sharp increase in nominal yields of government bonds, emerged in the euro zone. Since 2012, when ECB committed itself to decrease the nominal yields of indebted euro zone countries, real interest rate differentials have been decreasing again.

The 2008 financial breakdown influenced real interest differentials of these two regions in different ways. In the USA, real interest rate differentials depend solely on the inflation differentials, as USA issue government bonds for all federal states, so there cannot be any nominal interest rate differentials. Situation in EMU is different as the resulting real interest rate differential is a function of both inflation differentials and nominal interest rate differentials. Inflation differentials in EMU were stable and decreasing during the last decade with the exception of years 2008 and 2009 when inflation differentials became divergent in EMU (see the Graph 9). Since 2008 inflation differentials were decreasing again while real interest rate differentials kept on rising with rising divergence of nominal interest rates. This fact shows that the effect of increasing nominal interest rate differentials outweighed the effect of decreasing inflation differentials. As was already argued, increase of nominal interest rates was caused by the debt crisis in euro area. Euro area debt crisis' influence on nominal interest rate resulted in the impact on real interest rate differentials.

The two-tail difference means test is also carried out to evaluate statistically whether the real interest rate differentials are similar in both USA and EMU. The null hypothesis of the test is that the difference of the means of real interest rate differentials in EMU and USA between 2002 and 2013 equals zero. On five per cent significance level the null hypothesis is not rejected as the resulting p-value equals to 0.187. See Appendix 4 for the full report of the two sample t-test carried out in Microsoft Excel. Based on these results, real interest rate differentials were therefore similar in both regions in this time period.

2.4 Results of analysis

The empirical analysis of both regions showed that European Monetary Union does not have more serious problems with inflation and real interest rate differentials than the USA; in fact, their situation is similar in many aspects. Inflation differentials were bigger in EMU in the pre-crises period compared to the USA; they increased proportionally to inflation differentials of the USA during the financial crisis and almost matched them in the after-crises period.

EMU's real interest rate differentials became smaller than those of USA in 2003, four years after the introduction of common currency, and remained smaller until 2010, when debt crisis in Greece emerged. The increase in real interest rate differentials stopped in 2012 as the ECB succeeded to reassure the financial markets of returns on the bonds of Euro zone countries. Even though real interest rate differentials are significantly bigger in EMU in the last year of the observed period, they display downward movement trend after the ECB's intervention and it is probable that they will keep decreasing in the future. Their current magnitude is therefore not considered as a serious problem.

The theoretical part of this paper explained that inflation and real interest rate differentials are present in every single currency area, as they are natural part of internal balancing mechanisms. Their presence in EMU, which was found in the empirical part of this paper, is therefore not surprising and not necessarily a negative fact. As was mentioned, similar analysis was conducted on other states and their local administrations. The case studies conducted by other authors presented in this paper showed that these differentials are present even in homogenous states as Canada, Japan and Australia when we measure the differences among their counties/regions. It is probable that some degree of inflation and real interest rate differentials would be found within the regions of any state. However, inflation and interest rate differentials are usually discussed in relation to possible negative impacts on the euro zone; the fact that they are common is often not mentioned.

Negative impacts of inflation and interest rate differentials are substantial as was analyzed in the theoretical part of this paper. It is therefore worthwhile to study them and to minimize their presence in EMU as well as in any other single currency area. However, emphasis on their importance for the EMU seems to be rather excessive after the comparison to the USA – a single currency area which stability is not doubted and could be taken as a hypothetical optimum currency area, and the yet it has very similar inflation and interest rate differentials to EMU. This fact suggests that the scenarios of doom of euro currency resulting

from previous analyses carried in the crisis period of inflation and interest rate differentials might be exaggerated.

Conclusion

The goal of this dissertation was to state whether the inflation and interest rate differentials in the European Monetary Union are significant. In the theoretical part inflation differentials are defined and their relation to the real interest rate differentials is stated via the Fisher's effect. Analysis of negative impacts of inflation and real interest rate differentials is included to state why it is important to study this phenomenon. Main arguments are those that under the condition of presence of the differentials in a monetary union, its monetary authority cannot effectively conduct monetary policy and self enforcing imbalances that are caused. The theory of optimum currency area is summed and by analysis of sources of inflation and real interest rate differentials emergence, these differentials are linked to this theory. Foundation of emergence of inflation differentials are of many kinds and it is very difficult to state a major cause that would explain emergence of the differentials. However, three categories of causes were described in this paper. The first category is composed of consumption preferences and governmental influences on prices, the second are structural reasons and the third one is represented by cyclical reasons. The theoretical part of this dissertation is concluded with an analysis of the opposing point of view on inflation and real interest rate differentials saying that these are not harmful for monetary unions and they can be overcome.

Second part of this dissertation is composed of empirical analysis of inflation and real interest rate differentials in European Monetary Union. It starts with the analysis of historic development of inflation and interest rates of member countries of EMU. These analyses showed that divergence is expected in the period of financial crisis, which is confirmed later in the following chapters of the paper. Results of analysis done by Carlo Favero are introduced to demonstrate how the differentials are used to measure the divergence among member countries of the euro zone. Methodology of Favero's paper is used for own calculations of the magnitude of the differentials in the same period plus two years that could not be included in previous analyses because of their year of publication. Surprising results were found as real interest rate differentials started to decrease in 2012. This analysis showed that the problems of differentials might have been only a reaction to the financial crises which started in 2008 and that European Monetary Union might not have serious problems with the differentials as is often suggested. However, this analysis does not enable us to state whether the magnitude of the differentials is too high or in acceptable levels. As there is no reliable theory covering computation of the optimal values of the differentials within a monetary

union, benchmark strategy is used to answer this question in the second part of the empirical analysis where the differentials of EMU are compared to the differentials of the USA. This analysis showed both graphically and statistically that there are only marginal differences between the differentials of the two monetary unions; it also showed that both entities reacted to the financial crisis in a similar way, even though the USA should have better internal balancing mechanisms. Analysis of this paper shows that European Monetary Union does not have significantly high inflation and real interest rate differentials. The main hypothesis of this paper, which is: "There are no significant inflation and interest rate differentials in the European Monetary Union." is therefore not rejected.

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List of graphs

Appendix

Appendix 1

Regression result

Regression statistics	
Multiple R	0.899397
R Square	0.808916
Adjusted R	0.794217
Standard Deviation	0.212221
Observation	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	2.478555	2.478555	55.03281	5.05841E-06
Residual	13	0.585491	0.045038		
Total	14	3.064046			

Appendix 2

Regression result

Regression statistics	
Multiple R	0.997834
R Square	0.995673
Adjusted R	0.99534
Standard Deviation	0.063274
Observation	15

ANOVA

	df	*SS*	*MS*	*F*	*Significance F*
Regression	1	11.97638	11.97638	2991.43	9.38899E-17
Residual	13	0.052046	0.004004		
Total	14	12.02842			

Appendix 3

t-Test: Two-Sample Assuming Equal Variances

	Weighted average US inflation differential	*Weighted Average EMU inflation differential*
Mean	0.6070981	0.972470895
Variance	0.1940938	0.236958688
Observations	12	12
Pooled Variance	0.2155262	
Hypothesized Mean Difference	0	
df	22	
	-	
t Stat	1.9277992	
P(T<=t) one-tail	0.0334439	
t Critical one-tail	1.7171443	
P(T<=t) two-tail	0.0668879	
t Critical two-tail	2.0738731	

Appendix 4

t-Test: Two-Sample Assuming Equal Variances

	Weighted average IR differential EMU	*Weighted average US IR differential*
Mean	0.9961834	0.607098056
Variance	0.7864964	0.194093811
Observations	12	12
Pooled Variance	0.4902951	
Hypothesized Mean Difference	0	
df	22	
t Stat	1.3611052	
P(T<=t) one-tail	0.0936303	
t Critical one-tail	1.7171443	
P(T<=t) two-tail	0.1872606	
t Critical two-tail	2.0738731	