The Yield Curve as a Predictor of Economic Activity – the Case of the EU-15

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Abstract
In this paper the ability of the yield curve to predict GDP activity was examined in countries of EU-15 – Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden and United Kingdom. The dataset contains the spread between 10-year and 3-month sovereign bonds and real GDP of the countries mentioned above between the years 2000 and 2013. The results showed that the prediction ability of the GDP growth or decrease was proven after year 2008 (the financial crisis) in Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom. Certainly the simple yield curve growth forecast should not serve as a replacement for the complex predictive models, it does, however, provide enough information to serve as a useful check on the more sophisticated forecasts. These findings can be beneficial for investors and provide further evidence of the potential usefulness of the yield curve spreads as indicators of the future economic activity

Keywords: yield curve, spread, GDP, slope, economic activity prediction
JEL codes: E43, E44, E47, G01

1. Introduction

Predicting of the future has always fascinated people, moreover economic forecasting doubles the interest by adding the chance of profit.

The yield curve – specifically the spread between long term and short term interest rates is a valuable forecasting tool. It is simple to use and significantly outperforms other financial and macroeconomic indicators in predicting recessions two to six quarters ahead.

The yield curve simply plots the yield of the bond against its time to maturity. Many market observes carefully track the yield curve's shape, which is typically upward sloping and convex. However when the yield curve becomes flat or slopes downward (the spread between 10-year and 3-month bond is negative) it may signal GDP decrease (recession).

This paper builds on a wide range of previous researches, but differs in some ways. Bernard and Gerlach (1998) in their paper showed empirically on eight countries that the slope of the yield curve is a good predictor of the real economic activity. Berk and van Bergeijk (2001) examined 12 euro-area countries over the period of 1970-1998 and found that the term spread contains only limited information about future output growth. Their work is based on the previous theoretical researches of Estrella and Hardouvelis (1991), Estrella and Mishkin (1996). There was proven the evidence that the slope of the yield curve and the future GDP activity are related together. However it is necessary to say that this rule was true until the end of 20th century and it mostly disappeared at the beginning of 21st century and appeared again during the financial crisis (from 2008) and later on (De Pace, 2011; Giacomini and Rossi, 2005; Chinn and Kucko, 2010). Most of the studies are focused on the relationship of the yield curve and GDP activity of United States of America.

The aim of this paper is to show if the yield spread possesses the predictive power of future economic activity in the countries of EU-15 and to examine if this rule was weaken at the beginning of 21st century and appeared again during and after the financial crisis.

Despite various researches, there is not any comprehensive theory that would prove the correlation between the yield spread and economic development of the country yet. Often we come

across the statements that have only theoretical basis without generally valid empirical evidence. Economic models are largely based on the argument that the yield curve tends to be flatter in the situation of the tight monetary policy and the economic slowdown typically occurs with a slight time lag.

Almost perfect tool containing the relevant future data provides the yield spread of government bonds. The simplest interpretation of the yield spread is through monetary policy of the country. Based on this criterion - relatively low spread reflects the restrictive and tight monetary policy and vice versa - high spread reflects loose monetary policy. We can find the theoretical justification for using of the spread in expectations hypothesis. It assumes that long term rate of return is the average of the current and expected future short term yields. The investor's decision to invest in short term or long term asset is completely irrelevant (Mishkin, 1990).

Dependence of the yield spread and GDP can be derived from their connection to the monetary policy of the state. As bond yields react to monetary policy as well as monetary policy is able to respond to the output of the economy, the yield curve assumes overlapping of policy measures and responses. The yield curve had the ability to reflect future production either directly or indirectly. Indirectly it comes to predicting of the future interest rate and the future monetary policy. It may also reflect the future production directly because of the 10-year yields may depend on estimates of the output of the economy in 10-years.

A question arises – how many months, quarters, years of future economic activity can be predicted by the yield spread? Based on the study of Bonser-Neal and Morley (1997) spread has the greatest ability in predicting one-year horizon (four quarters ahead).

2. Methodology and Data

There are many ways of using the yield curve to predict the future real activity. One common method uses inversions (when short term rates are higher than long term rates) as recession indicators. Obtaining predictions from the yield curve requires much preliminary work. There is the principle which needs to be hold: keep the process as simple as possible. Thus I avoided both complicated nonlinear specifications and a detailed search for the best predictor.

A yield curve may be flat, up-sloping, down-sloping or humped. The standard solution uses a spread (difference between two rates). The problem is to choose the spread between the right terms. The most used spread is between 10-year and 3-month bonds. The problem is that there are rarely bonds which mature exactly in 10 years (or 3 months). In that case the best solution is to use the yield curve, which shows us the yield of each maturity. Creating and calculating of the yield curve is a rather difficult task because there are many ways how to do it and every country uses different model of constructing.

The yield curves are constructed by Bloomberg, therefore the data for spreads were gained from Bloomberg. For the spread I chose 10-year state bond rate minus 3-month state bond rate (Estrella and Hardouvelis, 1991; Estrella and Mishkin, 1996). I used quarterly data for the spreads because the data for the economic activity are taken on quarterly basis as well. The data for real GDP can be found at Eurostat, OECD statistics or Bloomberg. The data of real GDP obtained and used in this paper are from OECD statistics, because the database of Eurostat was incomplete.

The selected countries are countries of EU-15 - Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxemburg, the Netherlands, Portugal, Spain, Sweden and United Kingdom. There is no previous research which would prove or reject the hypothesis of real GDP and bond spread dependence in Europe after the year 2000. This hypothesis was proven first for United States of America and later on for other countries of North America, Europe (western countries) and Asia (Japan).

As a measure of real growth four-quarter percent change in real GDP was used (thus the percent change of the quarter against the last year's same quarter was calculated, e.g. the change from 1Q2004 and 1Q2003 real GDP was used). GDP is standard measure of aggregate economic activity and the four-quarter horizon answers the frequently asked question – what happens the next year?

The sample period starts from 1Q2000 and ends on 2Q2013. This time range covers the period before financial crisis, period of financial crisis and period after financial crisis. The basic model is

designed to predict real GDP growth/decrease four quarters into the future based on the current yield spread (Bonser-Neal and Morley, 1997).

This was accomplished by running of a series of regressions using real GDP activity and the spread between 10-year and 3-month bond yields lagged four quarters (e.g. the interest rate spread used for 3Q2001 is actually from 3Q2000).

The last step is to find out if there is the change of behaviour of the spreads and GDP activity at the beginning of 21st century and after the year 2008 (De Pace, 2011).

To generate the GDP predictions the regression using the whole sample was run, and later on two divided samples of real GDP and spreads of each selected country (the sample is divided in 4Q2007/1Q2008, because this year was the previous year of financial crisis and should show some changes in prediction of the yield curve spread) were run.

The program software used for regression (ordinary least squares) was Gretl. EViews was used for plotting of figures.

The following equation was estimated for each country:

$$Real\ GDP_{t+4} = \propto + \beta * spread_t \qquad (1)$$

Where:
real GDPt+4 is a prediction of the future real GDP in time t+4
spreadt is spread between 10-year and 3-month state bonds in time t

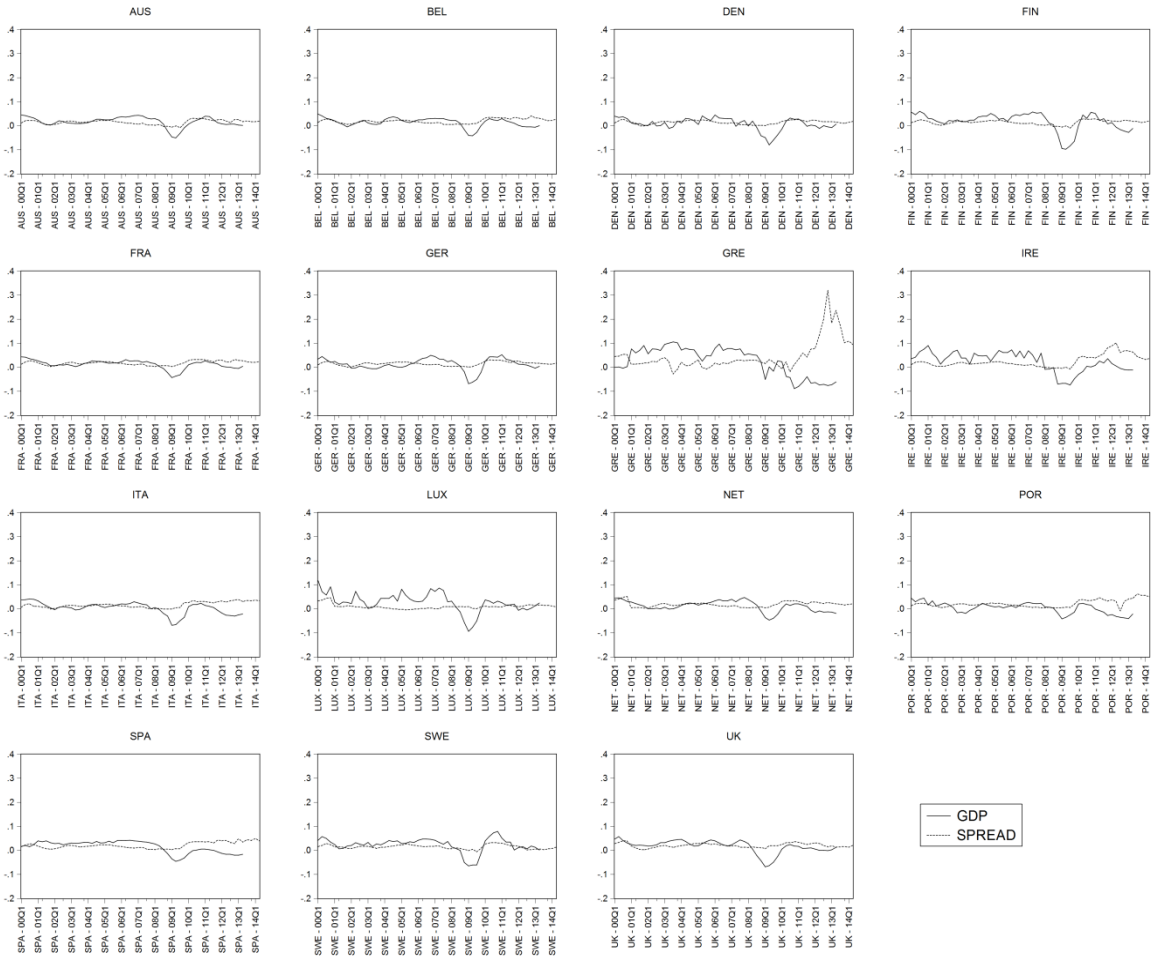
3. Results

Does the yield curve accurately predict the future GDP? First we can look at the data. Figure 1 shows the growth of real GDP and the lagged spread (4 quarters) between 10-year and 3-month bond yields in the countries of EU-15. A decline in the growth or real GDP is usually preceded by a decrease in the yield spread and narrowing yield spread often signals a decrease in real GDP growth. A negative spread usually precedes recessions, but not always. It is visible at the first sight that the dependency between real GDP and spread is quite visible in countries like Austria, Belgium, France, Germany, Ireland, Sweden and United Kingdom. Moreover the dependency is visible even more from the year 2008. The recession that began in 2009 was preceded by many quarters of decreasing spread and at the end was very close to zero. Big exception creates Greece, it is possible to see clear dependence between GDP and spread before year 2008 but not anymore.

When I constructed a scatterplot with each point representing a particular combination of real GDP growth and the lagged yield spread of selected countries, it showed that the relationship between the two variables is mostly positive. It means that positive real GDP growth is associated with a positive lagged yield spread and vice versa. Plotting the data gives a strong impression that the yield spread predicts future real activity.

To generate the GDP predictions a regression using the whole sample to generate each predicted data point was run.

Figure 1: Real GDP and spread in the countries of EU-15 (spread lagged four quarters)



Source: Bloomberg, OECD statistics, author's calculations in EViews

3.1 Results of regression for countries of EU-15 – whole sample

The whole sample of dataset contains the real GDP from 1Q2000 to 2Q2013. A regression of the whole sample was run and we got the results as seen in Table 1.

However it is necessary to say that we cannot contribute this model statistically significant for most of the countries (except of Finland, Greece and Sweden) because of very poor R^2 and very high p-value. Thus this model cannot be used as predictive model. It might be because of the different behaviour of the spread and GDP before and after the year 2008. This hypothesis will be tested later on.

The p-value is at low level under 10% for dataset of Austria, Denmark, Finland, France, Germany, Greece, Spain, Sweden and United Kingdom, however the R^2 coefficients, which show us how many percentage of the sample can be explained by these models, are very poor for countries mentioned above except of Finland, Greece and Sweden.

We have to say that there is not any proven dependency between the spread and real GDP in most of the countries. R^2 coefficient is quite low for Finland and Greece. This model can be used as predictive only for Sweden and Greece.

For example we can say that future real GDP of Sweden will be:

$$\text{Real GDP}_{\text{Sweden t+4}} = -0{,}0160664 + 2{,}64595 * \text{spread}_{\text{Sweden t}}$$

Table 1: The results of countries EU-15 and whole sample from OLS regression

Whole sample	Constant	Spread	P - value (F - test)	R^2
Austria	0,00403156	0,899854	0,001574	0,176295
Belgium	0,00887046	0,289927	0,262542	0,024079
Denmark	-0,0112690	1,37123	0,001213	0,183941
Finland	-0,0072672	1,86029	0,000463	0,211810
France	0,00421270	0,486408	0,074751	0,059792
Germany	-0,0049971	1,21377	0,002899	0,158187
Greece	0,0479321	-0,556068	4,96e-06	0,332837
Ireland	0,0268483	-0,111409	0,619454	0,004777
Italy	0,00429453	-0,065999	0,826827	0,000929
Luxemburg	0,0207602	0,795089	0,127164	0,044171
Netherlands	0,00832126	0,213791	0,430260	0,012007
Portugal	0,00889203	-0,281653	0,264003	0,023933
Spain	0,0294784	-0,750404	0,007131	0,131124
Sweden	-0,0160664	2,64595	1,03e-11	0,592457
United Kingdom	0,00175741	0,734386	0,074889	0,059737

Source: Bloomberg, OECD statistics, author's calculations in Gretl

3.2 Results of regression for countries of EU-15 – divided samples

The research continued as follows – the whole sample was divided into two samples. The first one is from 1Q2000 to 4Q2007, the second one is from 1Q2008 to 2Q2013 in order to show if there is any dependency between the variables before or after the financial crisis. Regressions of the first sample and the second sample were run. The results for the time span of 1Q2000 – 4Q2007 (first sample) are possible to see in Table 2, the results for the period of 1Q2008 – 2Q2013 (second sample) are in Table 3.

Table 2: The results of countries EU-15 and sample of period 1Q2000 – 4Q2007 from OLS regression

1Q00 – 4Q07	Constant	Spread	P - value (F - test)	R^2
Austria	0,0225365	0,154798	0,682625	0,005650
Belgium	0,0109919	0,671323	0,060923	0,112207
Denmark	0,00896117	0,686048	0,054216	0,118022
Finland	0,0319840	0,245137	0,571530	0,010791
France	0,0132759	0,499887	0,083530	0,096511
Germany	0,0200059	-0,241997	0,610143	0,008772
Greece	0,0824349	-0,944996	0,000900	0,311635
Ireland	0,0362481	1,06149	0,033029	0,142717
Italy	0,0113679	0,422271	0,299907	0,035765
Luxemburg	0,0414236	0,727023	0,050328	0,121733
Netherlands	0,0165545	0,345017	0,122638	0,077593
Portugal	0,0246891	-0,645053	0,166560	0,062795
Spain	0,0383463	-0,400022	0,042064	0,130678
Sweden	0,0168590	0,967944	0,012926	0,188908
United Kingdom	0,0234760	0,414211	0,046363	0,125825

Source: Bloomberg, OECD statistics, author's calculations in Gretl

Table 3: The results of countries EU-15 and sample of period 1Q2008 – 2Q2013 from OLS regression

1Q08 – 2Q13	Constant	Spread	P - value (F - test)	R^2
Austria	-0,013012	1,23340	0,000726	0,442802
Belgium	-0,013579	0,748380	0,037962	0,198028
Denmark	-0,038029	2,17219	0,001466	0,404472
Finland	-0,041128	2,49529	0,000441	0,468630
France	-0,023324	1,16381	0,001136	0,418622
Germany	-0,031897	2,35435	0,000201	0,507247
Greece	-0,011570	-0,266766	0,021240	0,238074
Ireland	-0,037931	0,628057	0,000618	0,451275
Italy	-0,030275	0,746168	0,060821	0,164830
Luxemburg	-0,039816	4,05401	0,030034	0,214314
Netherlands	-0,010748	0,402910	0,421126	0,032631
Portugal	-0,018598	0,246697	0,383541	0,038176
Spain	-0,013125	0,113764	0,674985	0,008973
Sweden	-0,028987	2,95430	4,75e-07	0,726575
United Kingdom	-0,042807	1,76924	0,009571	0,390996

Source: Bloomberg, OECD statistics, author's calculations in Gretl

It is clearly visible, that the dividing of sample made a great difference in results. In the first period (2000 – 2007) only model for Greece was statistically significant and its p-value was below 1% and R^2 could explain more than 31 % of the sample. All the other models could not be used as predictive models because of their statistical insignificance (high p-values ad low R^2).

The second period (2008 – 2013) showed big difference. Models for Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom can be used for future real GDP prediction however the model for Belgium, Greece, Italy, Luxemburg, the Netherlands, Portugal and Spain cannot be used due to its statistical insignificance.

The models for Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom have very low p-values (under 1%) and high R^2 which is in the most cases (except of United Kingdom) higher than 40%. The models are therefore usable for future prediction of GDP.

We can say that:

$\text{Real GDP}_{\text{Austria t+4}} = -0{,}013012 + 1{,}23340 * \text{spread}_{\text{Austria t}}$

$\text{Real GDP}_{\text{Denmark t+4}} = -0{,}038029 + 2{,}17219 * \text{spread}_{\text{Denmark t}}$

$\text{Real GDP}_{\text{Finland t+4}} = -0{,}041128 + 2{,}49529 * \text{spread}_{\text{Finland t}}$

$\text{Real GDP}_{\text{France t+4}} = -0{,}023324 + 1{,}16381 * \text{spread}_{\text{France t}}$

$\text{Real GDP}_{\text{Germany t+4}} = -0{,}031897 + 2{,}35435 * \text{spread}_{\text{Germany t}}$

$\text{Real GDP}_{\text{Ireland t+4}} = -0{,}037931 + 0{,}628057 * \text{spread}_{\text{Ireland t}}$

$\text{Real GDP}_{\text{Sweden t+4}} = -0{,}028987 + 2{,}95430 * \text{spread}_{\text{Sweden t}}$

$\text{Real GDP}_{\text{United Kingdom t+4}} = -0{,}042807 + 1{,}76924 * \text{spread}_{\text{United Kingdom t}}$

For example if there would be a change of 1% up in the spread of Austria then the GDP would increase about 1,22% (-0,013012+1,23340*1%).

The findings of De Pace (2011) were confirmed in Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom. The models should predict the future GDP well after 2008, however the model in Greece worked quite well before the financial crisis but not anymore. The countries where the model from 2008 to 2013 cannot be used are Belgium, the Netherlands,

Luxemburg, Greece, Italy, Portugal and Spain. The first group of countries creates so called BeNeLux, second group of countries can be classified as countries most affected by current debt crisis.

3.3 Prediction of real GDP in 2013 – Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom

At the end we can compute the future real GDP for Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom. The spreads are known from the year 2012 and 2013. The results are in the Table 4.

Table 4: The prediction of real GDP in the Czech Republic, Slovakia and Hungary

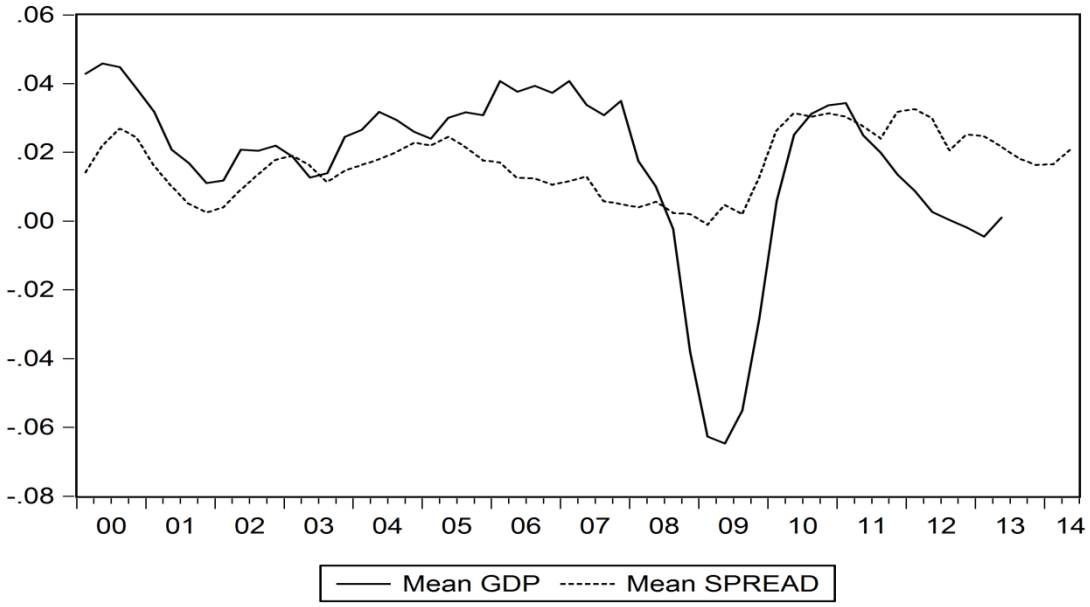
Prediction of GDP		**3Q2013**	**4Q2013**	**1Q2014**	**2Q2014**
Austria	spread	0,01934	0,01707	0,01612	0,01983
	GDP	0,010842	0,008042	0,00687	0,011446
Denmark	spread	0,01198	0,00967	0,01379	0,01744
	GDP	-0,01201	-0,01702	-0,00807	-0,00015
Finland	spread	0,01717	0,01354	0,01528	0,01889
	GDP	0,001716	-0,00734	-0,003	0,006008
France	spread	0,02178	0,020099	0,020112	0,023177
	GDP	0,002024	6,74E-05	8,25E-05	0,00365
Germany	spread	0,014414	0,01301	0,012791	0,017153
	GDP	0,002039	-0,00127	-0,00178	0,008487
Ireland	spread	0,04434	0,03658	0,03246	0,0366
	GDP	-0,01008	-0,01496	-0,01754	-0,01494
Sweden	spread	0,00225	0,00589	0,00842	0,013
	GDP	-0,02234	-0,01159	-0,00411	0,009419
United Kingdom	spread	0,01405	0,01485	0,01354	0,02037
	GDP	-0,01795	-0,01653	-0,01885	-0,00677

Source: Bloomberg, OECD statistics, author's calculations

The GDP of Austria should rise from 1,08% in 3Q2013 to 1,98% in 2Q2014. GDP of Denmark should be decreasing in all four predicted periods, GDP of Finland should increase in 3Q2013 by 0,17% and decrease in next two periods. GDP of France should be slightly increasing and GDP of Germany will be very close to zero each predicted period. GDP of Ireland is decreasing from 1% in 3Q2013 to 1,49% in 2Q2014. GDP of Sweden should be decreasing in periods 3Q2013, 4Q2013 and 1Q2014 and increasing in 2Q2014. GDP of United Kingdom should decrease about 1,79 % in 3Q2013 and about 0,67% in 2Q2014.

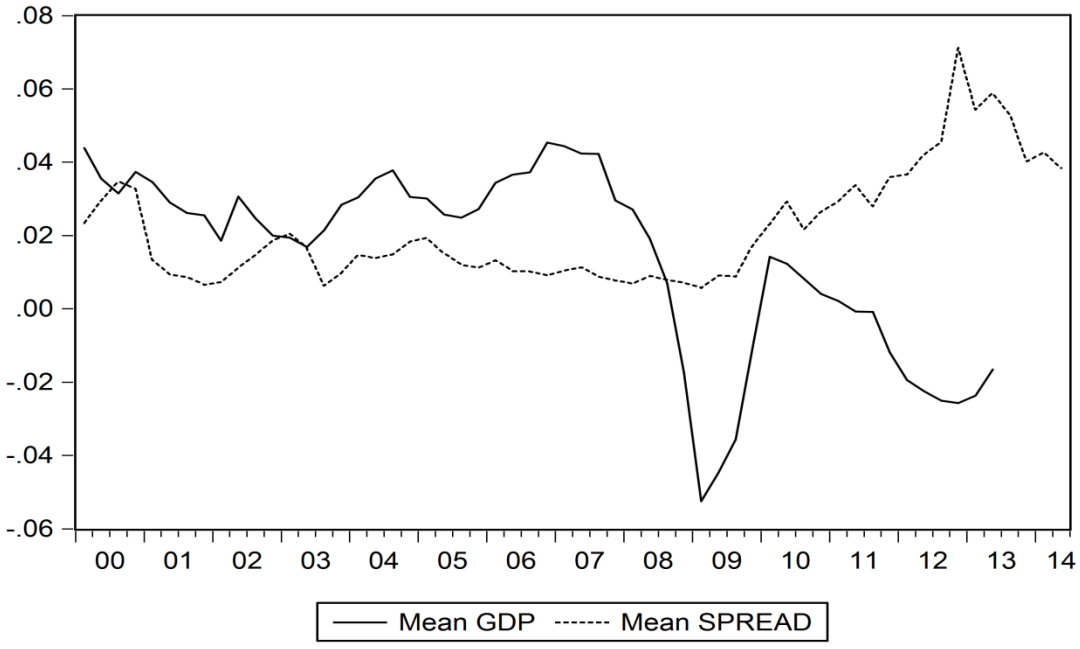
Figure 2 was plotted to show the dependence of GDP and spread of countries where the suggested model can be used as predictive (Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom). Mean of all values was calculated. Figure 3 shows big divergences after 2008 between GDP and spread of countries where the suggested model cannot be used as predictive (Belgium, Greece, Italy, Luxemburg, the Netherlands, Portugal and Spain).

Figure 2: Real GDP and spread in Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom together (spread lagged four quarters)



Source: Bloomberg, OECD statistics, author's calculations

Figure 3: Real GDP and spread in Belgium, Greece, Italy, Luxemburg, the Netherlands, Portugal and Spain together (spread lagged four quarters)



Source: Bloomberg, OECD statistics, author's calculations

4. Conclusion

Does the yield curve accurately predict the real economic growth? Answering this seemingly simple question requires a surprising amount of preliminary work. The 10-year, 3-month spread has substantial predictive power and should provide good forecast of real growth four quarters into the future. Nevertheless from 2002 to 2008 the predictive power of the yield curve was lowered in all the countries except of Greece. The results presented above confirm that 10-year, 3-month yield spread has significant predictive power for real GDP growth after the year 2008 in Austria, Denmark, Finland, France, Germany, Ireland, Sweden and United Kingdom. This paper confirms the previous work of De Pace, who says there was a break in the time of financial crisis and the hypothesis that future growth of GDP can be explained by spread of bonds did not work properly at the beginning of 21st century, however it started to work after 2008 again. It also proves that this spread model works even in the countries of Western and Northern Europe after year 2000, as the previous researches were done only before the year 2000.

The simple yield curve growth forecast should not serve as a replacement for the predictions of companies, who deal with predicting of many economic indicators, it however does provide enough information to serve as a useful check on the more sophisticated forecasts.

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