UNIVERSITE CATHOLIQUE DE LOUVAIN

LOUVAIN SCHOOL OF MANAGEMENT

and

NOVA SCHOOL OF BUSINESS AND ECONOMICS

Can the Yield Spread predict economic growth? An assessment for European countries

Supervisor at LSM: Sophie Béreau

Supervisor at Nova SBE: Paulo Manuel Marques Rodrigues

Research Master's Thesis

Submitted by: Rubens Guimarães Togeiro de Moura

With a view of getting the degrees

Master in Economics Master in Management

ACADEMIC YEAR 2013-2014

I would like to thank professors Paulo Rodrigues and Sophie Béreau for supervising me with valuable comments and suggestion throughout the execution of this work. I also would like to express my gratitude to all my "Double Degree" friends who followed me during this extensive academic journey: Diogo, Alberto, Marius, Natalie, Sonya, Marius, Thomas, Martynas and Monika. "Obrigado", "Gracias", "Danke", "Merci"... Thank you all! Special thanks to Monika who bravely spent with me the last couple of months: dziękuję!

Contents

1- Introduction

Reliable forecasts of future course of economic activity are crucial inputs in the decision making process of several economic agents. Firms, for instance, adjust their level of production and hiring policy accordingly by knowing whether the forthcoming state of the economy is more prone to be recessionary or expansionary. Likewise, Central Banks use this sort of information to decide on the stances of current and future monetary policy. For hedge funds, economic growth predictions contribute with a better design of investment strategies for their customers.

One possible method for constructing forecasting of economic growth is through financial variables. The usefulness of these technique lies on the possibility of building models of easy implementation by means of data that are usually reliable and readily available (Bonser-Neal and Morley, 1997, p.37). It was based on these sorts of data that Stock and Watson (1989) proposed a very straightforward and successful methodology for prediction future output: the so called yield spread (YS, hereafter), *i.e.*, the differential of the long and short term interest rates. The authors found that the presence of the YS was able to contribute significantly to anticipate the future behavior of the United States' economy. Specifically, it was observed that the higher the gap in the interest rates (*i.e.* the grater the yield spread), the more intense the forthcoming economic growth was expected to be.

As of Stock and Watson's (1989) contribution, the relationship between economic growth and the Yield Spread (YS, hereafter) was extensively investigated in the literature, being the United States (US) the economy mostly studied. By way of illustration, Haubrich and Dombrosky (1996) showed that a model containing the YS as the single regressors was able to outperform, on average, others forecasts based, for instance, on the index of leading economic indicators and a combination of lagged output and YS terms. It is also documented in the literature cases in which the inclusion of the YS enhances the predictive content of alternative specifications containing variables such as 3-month T-bills (Dotsey, 1997), real FED Fund (Estrella and Hardouvelis, 1991), past economic activities (Dotsey, 1997 and Estrella and Hardouvelis, 1991) and a combination of past inflation and index of leading indicators (Estrella and Hardouvelis, 1991).

The existing studies for European economies[1] are less numerous and less successful in confirming the predictive power of the YS (see *e.g.* Wheelock and Wohar, 2009). In a similar fashion as Dotsey (1997), Sedillot (2001), for Germany and France, and (Berk and van Bergeijk, 2000), for a set of 10 countries of the Euro Zone, concluded that it was very reduced the positive marginal contribution brought by the YS (or its lagged version in Berk and van Bergeijk, 2000) to output autoregressive models.

Motivated by the absence of an expressive quantity of publications dedicated to European economies, this study aims at contributing with the existing literature through both cross and within-country analysis, proposing a fully revision about the capability of the YS to act as a reliable leading indicator in the last three decades.

It is not our objective here find out the sort of estimation method that generates the most accurate forecasts. Rather, grounded in previous publications (as per in Berk and van Bergeijk, 2000, Sedillot, 2001, Hamilton and Kim, 2002, Bonser-Neal and Morley, 1997, among others), we are going to test the strength of the relationship between YS and economic growth when this is treated as linear. To this end, it will be thoroughly investigated whether the predictive content of the YS is sensitive to (i) changes in forecast horizons; (ii) the matter as economic activity is measured; (iii) drastic macroeconomic downturn, namely the Global Financial Crisis which started in 2008 and (iv) different forecasting techniques. Ultimately, it is intended to provide complementary insights to the analysis of Berk and van Bergeijk (2000) and Sedillot (2001). In particular, we will verify whether the lack of predictive power of the YS in presence of past economic activity can be extended for a different set of countries and for a sample period posterior to the implementation of the monetary union.

Besides this introduction, this study is structured in four more sections. Section 2 reviews some of the theoretical arguments for justifying the relationship between economic growth and the differential of long and short interest rates. Afterwards, the validity of the same relation will be empirically tested and thoroughly analyzed in the next two sections. Lastly, section 5 summarizes the main empirical findings obtained in the previous parts.

[1] Wheelock and Wohar (2009) documented also unsuccessful outcomes for Japan.

2- Why might the Yield Spread predict economic growth? A theoretical assessment

One can find in the current literature mainly two different underlying causes for explaining the positive relationship between yield spread and future economic activity. One has its roots in the path of monetary policy adopted by Central Banks, and the other focuses on consumers' investment decisions over time. In what follows, we will briefly describe some of the general features of each theory.

2.1 Explanations based on the stance of Monetary Policy

There are different theories which resort to monetary policy arguments to advocate in favor of a legitimate YS-economic growth relationship. In what follows, we will shed some lights on the most disseminated theories in the literature.

a) Expectations hypothesis: This theory prescribes that one can build a yield curve based on the following equation:

$$y_t^{(N)} = \frac{1}{n}\sum_{i=1}^{n-1} E\left[y_{t+i}^{(1)}\right] + \theta_t \qquad (2.1)$$

where $y_t^{(N)}$ stands for the yields of a n-period zero-coupon bond, θ_t is the risk premium in period t and E[.] the expectations operator.

In addition to a risk-premium, we can also observe that the long-term rates can be computed as a weighted average of expected future short-term rates. The rationale of this theory lies in the premise that investors may not expect to acquire different returns by investing in bonds of different maturities - otherwise they would be able to realize arbitrage gains. Moreover, the uncertainty associated with the path of future short-term interest rates makes investors demand a risk premium for holding bonds of higher maturities. In these circumstances, as the long-term interest rates would tend to become larger than short-term rates, one may find a reason to justify a positive slope of the yield curve.

Given the arguments in favor of a positive slope of the yield curve, one may be interested in thinking about: (i) the possible causes that make the slope of the yield curve negative and (ii) the relationship between this reversion and the future occurrence of economic slowdown periods.

According to Passaro (2007), changes in interest rates' risk premium are thought to be insignificant, at least in the short-run. In this manner, the source of change in the signal of the yield spread should be attributed to fluctuations in the future short-term interest rates. In particular, the expectation that a recessionary period is approaching leads investors to believe that Central Banks will decrease future interest rates in order to stimulate and sustain the level of output. Therefore, the belief that an expected deterioration in future economic activity will follow, flattens – and eventually inverts - the slope of the yield curve.

b) Counter cyclicality of Monetary Policy: Central Banks are able to speed up or slow down the rate of economic growth of a particular country by performing changes in the level of interest rates.

As a manner of promoting a faster economic growth in the short-run, Central Banks may adopt an increase in money supply, which will result in a reduction of both long and short term interest rates. The impact of these reductions, however, is not identical. As stated by Estrella, Rodrigues and Schich (2000), a loose monetary policy leads to a greater decline in the short-term interest rate. The argument for that is that a reduction in the short-term interest rate may generate a higher inflation rate and, as a manner to counterbalance the increase in the price level, Central Banks may wish to increase forthcoming interest rates. Therefore, one may realize a positive relationship between the slope of yield spread and future economic output.

By the same token, one may expect an analogous outcome for the case when Central Banks opt for a tighter monetary policy. Shrinkage in money supply may lead to a less steep yield curve – as one may expect a more intense increase in the short term interest rate than in those of longer maturities - followed by a slower rate of economic growth.

c) The importance assigned by policymakers to future inflation: following a procedure centered less on a “heuristic” and more on an “explicit model” basis (Estrella, 2005, p. 3), Estrella, (2005) and Estrella (1997) demonstrate analytically the pertinence between a positive sign of the yield spread and future real activity, through the incorporation of the following tools: a Phillips curve, a dynamic IS curve, the Fisher equation, the expectations hypothesis and the monetary policy rule of which the Taylor Rule is an example (Estrella, Rodrigues and Schich, 2000, p.7).

The conclusions that can be found in Estrella (1997) are that the predictive power of the yield curve is partially related with the preferences that policymakers have over the deviation of both output and inflation from their target (Duarte, Venetis and Payá, 2004). In particular, this relationship is especially robust when the monetary policy is exclusively focused on the promotion of output growth, whereas the correlation becomes weaker when Central Banks target to combat inflation only. Estrella (2005) adds to these results that the yield curve, as a leading indicator, performs (i) greatly when monetary authorities are more concerned with changes in the interest rate, alternatively to its levels and (ii) rather poorly, when Central Banks' reactions to both inflation and output deviations approaches infinity.

2.2 - Explanations based on consumers' intertemporal choice

The origin of this approach is supported by the works of Harvey (1988)[2] and Hu (1993)[2]. Resorting to microeconomic foundations, the authors develop models for determining the consumers' optimal level of consumption over time.

A core assumption of these models is that consumers are better off by having a stable income stream regardless of the stage of the Business Cycle than the situation in which they experience high levels of income during expansionary periods and low income during downturns. In this sense, in a world where the only financial asset available to be invested is a default-free bond, consumers would prefer to hold long term bonds when they expect a future period of recession. By acting in this manner, one will observe an increase in the demand for these bonds, leading to an increase in their prices and, hence, a reduction in their yield. Moreover, consumers may wish to fund the acquisition of the long-term bonds by selling bonds of shorter maturities. This behavior would result in an increase in the yield of short-term bonds.

[2] References retrieved from Passaro (1997) and Moneta (2003).

Given the theoretical arguments to support the positive relationship between the YS and economic growth, it is relevant to assess their empirical validity. The next sections aim to provide an in-depth investigation of the strength of this relationship in a sample of 12 European countries.

3- Data description

We tested the quality of the YS as a leading indicator the following countries: Belgium, France, Germany, Ireland, Italy, Netherlands, Norway, Portugal, Spain, Switzerland, Sweden and the United Kingdom. The criteria chosen in the selection of these countries was based on the availability of data. In particular, European economies were chosen for which we could find quarterly data starting from the beginning or the middle of the decade of 1980 (a more precise description is presented in the appendix A). For all countries considered the last data available is the last quarter of 2013.

Regarding the constructions of the variables of interest, the yield spread was computed in consonance with the procedure widely used in the literature. In particular, Moneta (2003) has found that the spread that results from the 10-years minus 3-months rates outperforms any other spread, when one is interested in comparing different forecasts. In this manner, for each country of the sample, the yield spread was computed as:

$$YS_t = i_{10Y} - i_{3M} \tag{3.1}$$

where the i_{10Y} corresponds to the yield on government bonds with a maturity of ten years and i_{3M} to the 3-month money market rates[3]. Both series were extracted from Eurostat. A historical series from each country can be found in the appendix A.

Concerning the measurement of economic activity, two indicators were adopted: Real Gross Domestic Product (real GDP, hereafter) and Industrial Production (IP, hereafter). Both series

[3] It is common practice in the literature which analyzes the case of the US to treat the short term interest rate as the 3-months T-bills interest rates. For the countries of the European Union, after the implementation of the Euro as common currency created a lack of a specific short term government bond for every country which joined the monetary union. In these circumstances, one has decided to replace this rate for the one which is the most representative rate according to the Eurostat: the interbank 3-month money market rate.

were collected on a quarterly basis from the OECD's database. The real GDP series used was the one which accounts for the volume estimates, based on fixed PPPs, with seasonally adjustment (expenditure approach), whereas the IP refers to the Production and Sales index (MEI).

In order to obtain the average annualized growth of future economic activity (represented by the variable g) over the next *k* quarters, one has computed:

$$g_{t\to t+k} = \frac{400}{k} \ln \frac{Y_{t+k}}{Y_t} \qquad (3.2)$$

where k was estimated from 1 to 8 quarters ahead and Y denotes both real GDP and IP for each country.

It is relevant to highlight that all data used in this analysis is revised data and not real time based. The reason for this choice lies in the fact that one aims at investigating the "true" realization of economic growth rather than their expected, preliminary values.

4- Empirical estimation

Having collected data of interest rates and future economic activity, we may test the predictive power of the yield spread over the economic growth. The analysis will be performed in two stages, and through two different forecasting techniques. In a first moment, one adopts an in-sample procedure, which consists in estimating an average relationship of explanatory variables over the dependent variable, taking into account the whole sample period. In this sense, one estimates a single coefficient for the whole sample period, despite of the fact that some information was not available for market participants in the moment that the forecasting was carried out (Bonser-Neal and Morley, 1997, p.41). The second technique explored is the so called out-of-sample. Under this framework, one performs the forecasting based exclusively on the existing information to market participants at some moment in time. In particular, one re-estimates the parameters of the model as new information becomes available.

The estimation of the models of interest, for both forecasting techniques, was made through Ordinary Least Squares (OLS, hereafter). According to Moneta (2003), an issue related with this procedure lies in the fact that overlapping forecast horizons may generate autocorrelation in the error terms, making the standard errors no longer valid. To correct for this drawback, we performed an OLS estimation with Newey and West (1987) standard errors.

In the next following sub-sections, a separate analysis about the performance of both forecasting techniques will be conducted for (i) the whole period for which one has data available (from early 1980 to 2013) and (ii) the period that ends with the Global financial Crisis of 2008 (which was set as the last quarter of 2008, period that was marked by Lehman Brother's bankruptcy). In order to fully test the predictive power of the yield spread, one will confront the quality of their forecasts with some of the benchmarks widely used in the literature.

Before initializing the complete analysis of the aspects mentioned previously, we tested whether the Yield Spread series satisfy the conditions of stationarity.

4.1) Unit root tests

Examining stationarity is crucial when dealing with time series data. An inappropriate treatment of non-stationary may generate the problem of spurious regressions. A potential source of this issue, as documented by Bueno (2008), is related with the realization of regressions in which the series present different orders of integration.

Bearing in mind the existence of this trouble, one has opted to investigate the possibility of unit roots in YS series through the traditional Dickey-Fuller test (DF, hereafter). In this manner, we proceeded by conducting a test in which the underlying model includes a time trend and constant. The null hypothesis H_0 is the existence of a unit root, while H_a states that the series is stationary. We also tested for a unit root in the first difference of the series based on a test regression which included a constant term only. The rejection of the null hypotheses in all cases favors the evidence that the series is stationary.

The outcomes of the DF tests are shown in tables DF.1 and DF.2 for the full- sample and for the periods prior to 2008, respectively. Based on the critical values of the DF distribution, we indicate in red the entries which reveal indication that the series are not stationary.

Table DF.1 - Unit root test for YS series: Dickey Fuller statistics - Whole period [4]

	Belgium		France		Germany		Ireland	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-4,45	0,003	-3,524	0,003	-3,68	0,027	-3,925	0,015
Intercept	-4,16	0,001	-3,344	0,015	-3,72	0,005	-2,985	0,040

	Italy		Netherlands		Norway		Portugal	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-4,075	0,009	-3,42	0,054	-3,863	0,017	-2,31	0,426
Intercept	-1,937	0,314	-3,28	0,018	-3,634	0,007	-1,88	0,340

	Spain		Sweden		Switzerland		UK	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-4,49	0,002	-3,764	0,022	-3,45	0,049	-3,482	0,046
Intercept	-3,36	0,014	-3,509	0,010	-2,23	0,196	-2,877	0,051

Table DF.2 - Unit root test for YS series: Dickey Fuller statistics – Prior to 2008[4] 4 por encima de

	Belgium		France		Germany		Ireland	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-3,88	0,02	-3,016	0,003	-2,90	0,165	-3,959	0,014
Intercept	-4,05	0,00	-3,224	0,021	-3,04	0,034	-3,758	0,005

	Italy		Nethelands		Norway		Portugal	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-3,111	0,109	-2,47	0,341	- 2,82	0,193	-3,38	0,061
Intercept	-2,859	0,053	-2,52	0,113	-2,820	0,059	-3,40	0,013

	Spain		Sweden		Switzerland		UK	
	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value	DF statistic	p-value
Trend + Intercept	-4,59	0,002	-2,623	0,272	-2,42	0,37	-2,981	0,143
Intercept	-4,32	0,001	-2,582	0,101	-2,08	0,25	-2,874	0,052

[4] The test was performed to a level of significance equal to 10%, in which the critical values of the distribution are the following:

a) Trend + intercept: -3,15
b) Intercept: -2,58

As one can observe directly from the previous tables, some series are non-stationary[5]. Due to that, the estimation of regressions containing these series will deserve a special treatment, which will be further explained in the next section.

4.2) In-sample estimation

4.2.1) An assessment of the Yield Spread of the full sample

The in-sample procedure consisted in the distinct estimation of regressions, by country and by different forecasting time horizons. In particular, for each economy that has shown to be stationary, the following equation – which will be named YS model hereafter - was estimated:

YS model:

$$g_{t \rightarrow t+k} = \alpha_0 + \alpha_1 YS_t + \varepsilon_{t+k} \tag{4.1}$$

and for those in which unit roots were diagnosed, the first difference of the YS was used:

$$g_{t \rightarrow t+k} = \alpha_0 + \alpha_1 \Delta YS_t + \varepsilon_{t+k} \qquad (4.1)'$$

Recall that the forecasting period ranged from one to eight quarters ahead, *i.e*, k =1,2 ..., 8. The criteria set for this choice is aligned with Hamilton and Kim (2002) and Sedillot (2001), which portray that the predictive power of the slope of the yield curve over economic growth lasts up to two years. Provided the fact that the dependent variable is measured as the growth rate of both industrial production and real GDP, the "YS-IP model" will be used to allude to the former set of regressions, whereas "YS-GDP model" will be implemented for the latter one.

Before proper examining the predictive power of YS model, one may be interested in quantifying the expected impact that changes in the yield spread may entail over future economic activity. Tables B.1 and B.2 (see appendix B) show that, apart from some rare exceptions, an increase (decrease) of 1% in Yield Spread – or the first difference of that, for the countries in which the YS is not a stationary series - impacts positively (negatively) less

[5] Even though Italy in the series which includes the period prior to 2008 has shown a DF statistic slightly below the critical value of interest, one has decided to include it in the group of stationary countries.

than 1% on the future productive path of a particular economy. This outcome is consistent with the estimations found by Haubrich and Dombrosky (1996) and Ang, Piazzesi and Wei (2006)[6] for the US and Bonser-Neal and Morley (1997) for a set of industrialized countries. The exact estimated values for the slope coefficients (α_1) and their respective standard errors can be found in respective appendix section.

As a manner of quality assessment of the YS models, we decided to resort to the use of the R-squared and the Mean Absolute Deviation (MAD, hereafter). The choice for both tools, rather than just one of them lies in the fact that they provide different information about the forecasting properties of the model. The R-Squared can be interpreted as a measure of correlation between the predicted and the actually realized values. In other words, it assesses how variations in the dependent variable are explained by variation in the covariates. The MAD, in turn, provides an average measure of the lack of precision of predicted values.

For the full sample, the estimated outcomes are presented in tables IS.1 through IS.2 for the R-Squared, and in tables IS.3 through IS.4 for the MAD. Throughout, the lines in orange will correspond to the cases in which one has measured the YS as its first difference.

The values of the R-Squared for each time forecasting horizon were computed by the following formula:

$$R^2 = 1 - \frac{\sum_{t=1}^{T}(g_{t+k} - \hat{g}_{t\to t+k})^2}{\sum_{t=1}^{T}(g_{t+k} - \bar{g})^2} \tag{4.2}$$

where $\hat{g}_{t\to t+k}$ represents the fitted values and $\bar{g}$, the sample average.

Table IS.1 – Estimated R-squared: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: IP

[6] The comparison made here is made with the 5-years term spread, the longest one used by the authors.

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	9,1%	14,3%	18,9%	19,6%	19,8%	18,5%	18,1%	18,5%	**17,1%**
France	8,7%	11,2%	12,5%	13,0%	12,4%	10,7%	9,1%	8,4%	**10,8%**
Germany	14,3%	20,4%	24,0%	27,2%	30,3%	32,1%	33,0%	33,5%	**26,8%**
Ireland	0,5%	1,9%	3,9%	4,7%	6,6%	8,7%	9,4%	9,9%	**5,7%**
Italy	0,7%	0,7%	0,0%	0,3%	0,4%	0,6%	0,4%	0,2%	**0,4%**
Netherlands	2,6%	5,2%	5,4%	5,8%	5,1%	3,9%	3,4%	2,6%	**4,2%**
Norway	0,6%	1,0%	2,2%	4,0%	4,8%	4,6%	4,6%	5,4%	**3,4%**
Portugal	0,8%	1,2%	3,2%	1,1%	0,5%	0,6%	0,1%	0,2%	**1,0%**
Spain	0,3%	0,7%	0,9%	0,6%	0,2%	0,2%	0,5%	0,7%	**0,5%**
Sweden	11,7%	15,9%	15,9%	14,5%	11,6%	7,9%	4,9%	3,0%	**10,7%**
Switzerland	0,0%	0,0%	0,4%	0,6%	0,4%	0,9%	0,8%	0,9%	**0,5%**
United Kingdom	1,7%	3,9%	5,3%	6,5%	6,3%	5,3%	4,2%	3,7%	**4,6%**

Without a doubt, one observes that the most remarkable aspect refers to the poor predictive performance of the model proposed. One can notice that the explanatory power of the yield spread often overcomes the barrier of 10% for most of the time horizons - value that is rather inferior to those obtained by Haubrich and Dombrosky (1996) and Bonser-Neal and Morley (1997) - in only 4 out of the 12 economies examined. The high level of diversity in the outcomes is worth pointing out: while the yield spread has demonstrated to be a fair predictor of the future industrial production for Germany (especially for horizons superior to one year), in other countries such as Italy, Portugal, Spain and Switzerland the same measure has shown to be a rather ineffective leading indicator. Furthermore, one may observe the increasing predictive power of the explanatory variable over the first year; followed by a reduction in subsequent periods.

Bearing in mind the historical perspective of more than three decades, the replacement of Industrial Production by real GDP growth as a measure of real economic activity does not transform the yield spread model in a satisfactory one (see table IS.2). With few exceptions, the R-squared continues to present values of reduced significance. However, one difference between the YS-IP and YS-GDP models can be pointed out, namely, the increased predictive power over the second year of the horizon analyzed of the latter model.

Table IS.2 - Estimated R-squared: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	8,0%	10,9%	10,8%	9,7%	9,5%	9,9%	10,5%	11,8%	**10,2%**
France	6,2%	9,0%	10,3%	11,6%	12,1%	12,1%	11,8%	11,5%	**10,6%**
Germany	5,0%	8,5%	10,3%	11,6%	12,3%	12,6%	13,2%	13,5%	**10,9%**
Ireland	0,5%	1,2%	1,8%	2,5%	3,2%	3,4%	3,3%	2,6%	**2,3%**
Italy	0,2%	0,1%	0,0%	0,0%	0,1%	0,1%	0,0%	0,2%	**0,1%**
Netherlands	1,7%	3,1%	4,6%	6,0%	7,3%	7,6%	7,6%	6,9%	**5,6%**
Norway	2,6%	5,8%	5,3%	3,8%	5,0%	5,7%	6,8%	6,1%	**5,1%**
Portugal	0,0%	1,4%	1,9%	2,1%	3,0%	2,5%	1,7%	1,3%	**1,7%**
Spain	0,1%	0,1%	0,3%	0,4%	0,4%	0,3%	0,3%	0,3%	**0,3%**
Sweden	22,7%	35,7%	42,2%	41,3%	38,1%	34,9%	31,5%	29,5%	**34,5%**
Switzerland	0,1%	0,2%	0,4%	0,1%	0,2%	0,1%	0,2%	0,1%	**0,2%**
United Kingdom	2,2%	3,9%	5,0%	6,0%	6,8%	6,9%	7,1%	7,2%	**5,6%**

A case by case comparison with the previous model estimated, evidences rather heterogeneous outcomes. In comparison to the regressions in which IP growth was used as dependent variable, the models with real GDP growth performed: (i) slightly worse for short maturities (up to the horizon of one year) and slightly better for longer maturities (cases of France, Netherlands); (ii) slightly better for the overall period analyzed (United Kingdom); (iii) slightly better (Norway) or slightly worse (Belgium and Ireland) for all maturities; (iv) likewise extremely unsatisfactory (Italy, Portugal, Spain and Switzerland) and (v) drastically different, in a positive manner (Sweden) or in a negative one (Germany).

In addition to the R-squared, we have also estimated the MAD:

$$MAD = \frac{\sum_{t=1}^{T} |e_t|}{T} \tag{4.3}$$

where e_t is the forecasting error of period t, i.e., the difference between the value predicted by the model and the value effectively realized. This indicator enables one to compare the forecasting performance across countries and time horizons, regardless of the number of observations available for each country. A summary of this indicator is presented in tables IS.3 and IS.4.

Table IS. 3 – MAD: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,39	4,09	3,42	3,00	2,54	2,33	2,14	2,04	**3,12**
France	3,48	2,82	2,59	2,33	2,19	2,08	2,00	1,90	**2,42**
Germany	5,10	4,21	3,77	3,33	2,99	2,66	2,47	2,33	**3,36**
Ireland	11,87	7,84	6,42	5,69	4,94	4,68	4,69	4,69	**6,35**
Italy	5,09	4,15	3,87	3,61	3,37	3,15	2,96	2,77	**3,62**
Netherlands	6,36	4,10	2,98	2,50	2,28	1,93	1,75	1,55	**2,93**
Norway	9,09	5,33	4,32	3,65	3,24	3,06	2,87	2,77	**4,29**
Portugal	5,84	4,22	3,65	3,53	3,31	3,19	3,12	3,05	**3,74**
Spain	3,14	3,07	7,12	5,04	4,11	3,64	3,24	2,95	**4,04**
Sweden	2,70	2,59	5,82	4,30	3,94	3,53	3,30	3,11	**3,66**
Switzerland	4,80	3,88	3,62	3,41	3,28	3,14	3,03	2,93	**3,51**
United Kingdom	3,36	2,73	2,44	2,22	2,09	1,99	1,92	1,85	**2,33**

Table IS.4 – MAD: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,89	1,53	1,33	1,22	1,11	1,04	0,95	0,88	**1,24**
France	1,45	1,25	1,13	1,06	0,99	0,93	0,88	0,85	**1,07**
Germany	2,68	2,03	1,66	1,50	1,43	1,34	1,25	1,18	**1,64**
Ireland	5,45	4,14	3,73	3,47	3,30	3,18	3,08	3,02	**3,67**
Italy	2,93	2,12	1,82	1,66	1,56	1,46	1,37	1,30	**1,78**
Netherlands	2,10	1,87	1,68	1,57	1,51	1,45	1,43	1,38	**1,62**
Norway	3,90	2,18	1,78	1,58	1,37	1,32	1,22	1,17	**1,82**
Portugal	1,24	3,33	2,54	2,31	2,24	2,14	2,13	2,06	**2,25**
Spain	2,08	2,05	1,92	1,67	1,54	1,45	1,36	1,28	**1,67**
Sweden	1,21	1,13	2,73	1,94	1,61	1,49	1,42	1,40	**1,62**
Switzerland	2,06	2,00	2,43	1,93	1,83	1,77	1,72	1,69	**1,93**
United Kingdom	2,11	1,87	1,73	1,62	1,54	1,49	1,45	1,42	**1,65**

The previous tables provide some interesting insights. First, the lack of accuracy exhibited by the models is evident. On average, the framework adopted mispredicts future economic growth in (i) more than 1 percentual point for the YS-GDP model and (ii) at least, 2.3 percentual points for the YS-IP model. Second, the choice of the dependent variable turned out to be relevant as it alters substantially the average forecasting error and favors the YS-GDP models. Nevertheless, switching the dependent variable does not largely modify the comparative performance across countries. In other words, economies that demonstrated the best outcomes in one of the models continue to behave alike in the other (e.g. France, the

Netherlands and Belgium), and being the same verified for those which performed the worst (e.g. Portugal, Ireland and Norway). Thirdly, one remarks that it is a common feature of both YS models that the MAD decreases as the forecasting horizons increase. The only countries which do not prove comply to this are Portugal (when real GDP is assumed as dependent variable) and Sweden (for both cases), for all the others the lowest mean forecasting error is observed in 8 quarters ahead.

It is also relevant to examine whether the comparative performances across countries are sensible to the method that one uses to compute them. In other words, one may wish to know whether, for a particular country, the selection of either the R-Squared or the MAD changes the judgment about the predictive strength of the model. An answer to this question can be obtained from Tables IS.5 and IS.6.

Table IS.5 – MAD: Average of YS models – Whole Period

France	1,75
United Kingdom	1,99
Belgium	2,18
Netherlands	2,28
Germany	2,50
Sweden	2,64
Italy	2,70
Switzerland	2,72
Spain	2,86
Portugal	2,99
Norway	3,05
Ireland	5,01

Table IS.6 – R-Squared: Average of YS models – Whole Period

Sweden	22,6%
Germany	18,9%
Belgium	13,6%
France	10,7%
United Kingdom	5,1%
Netherlands	4,9%
Norway	4,3%
Ireland	4,0%
Portugal	1,4%
Spain	0,4%
Switzerland	0,3%
Italy	0,3%

The value of each entry in the previous tables was computed by taking the simple average of the respective indicator of both YS models for the period that preceded 2008. After that, we built a ranking of performance, with countries ordered in a decreasing manner.

From the previous tables, it is not possible to observe substantial changes in the placements of the economies. The aspect which draws attention is the case of Ireland: the R-squared would qualify the country as one of average comparative performance, whereas MAD suggests, by far, the worst achievement.

One can list similarities and differences between the results provided by the estimates of the MAD and R-squared. Regarding the common points, one may notice that overall both indicators suggest a poor performance of the YS models (especially when the aim of the prediction is up to 2-quarters ahead), apart from the decision of the dependent variable. Furthermore, a comparative analysis across countries about the quality of the forecasting preserves a similar ordination for both cases. In particular, Belgium and France have demonstrated superior performance *vis-à-vis* the majority of the economies, UK is placed in the middle of the list and other countries such as Portugal and Spain have shown to be among the poorest fits for both YS models. A clear difference between the models lies in the time horizon in which the forecasting becomes more effective: while the MADs favor the predictions of 2 years-ahead, the R-squared does not provide any conclusive information about this aspect.

4.2.2) The impact of the Global Financial Crisis of 2008

Having concluded that the historical performance of the Yield Spread as a leading indicator is rather unsatisfactory, one may wish to observe the behavior of the indicator during less turbulent economic periods. In order to do so, a similar analysis as in the previous section was carried out, with the difference that the period from 2008 to 2013 was excluded from the assessment.

Before shedding some lights on the effects of the Financial Crisis, one may wish to compare exclusively the accomplishment of both YS models before 2008 (see tables IS.7 and IS.8). Overall, it is clear that the adoption of real GDP as a dependent variable has a positive impact on the fit quality of the model for countries such as France, Germany, Italy, Ireland and the UK. A remarkable exception is Sweden: the replacement of IP by real GDP ruins the capability of the model to predict the countries' future economic activity. Portugal and Belgium also corroborate this outcome.

Table IS.7 - Estimated R-squared: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Industrial Production

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	10,3%	18,4%	25,7%	28,2%	29,2%	26,8%	26,8%	27,0%	**24,0%**
France	9,2%	11,8%	12,2%	11,9%	10,2%	7,6%	6,2%	5,8%	**9,4%**
Germany	0,0%	0,3%	0,1%	0,2%	0,2%	0,3%	0,8%	1,2%	**0,4%**
Ireland	1,6%	1,7%	0,7%	1,0%	0,9%	0,1%	0,0%	0,3%	**0,8%**
Italy	0,3%	0,2%	0,1%	0,0%	0,5%	1,4%	2,7%	3,8%	**1,1%**
Netherlands	3,6%	8,1%	3,7%	4,0%	5,4%	3,6%	4,2%	2,1%	**4,3%**
Norway	0,0%	1,1%	1,4%	0,3%	0,0%	0,0%	0,4%	0,2%	**0,4%**
Portugal	4,9%	10,9%	17,3%	25,8%	27,9%	29,0%	28,2%	25,9%	**21,2%**
Spain	0,7%	0,9%	1,0%	0,5%	0,1%	0,0%	0,2%	0,5%	**0,5%**
Sweden	2,9%	6,1%	11,1%	12,8%	12,4%	9,6%	7,9%	10,7%	**9,2%**
Switzerland	0,0%	0,1%	0,6%	1,0%	0,7%	1,1%	1,3%	1,6%	**0,8%**
United Kingdom	1,1%	0,2%	0,2%	0,1%	0,2%	0,3%	0,2%	0,6%	**0,4%**

Table IS.8 - Estimated R-squared: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	13,0%	19,1%	19,8%	18,5%	18,2%	19,1%	20,5%	22,6%	**18,9%**
France	10,4%	13,4%	14,2%	15,5%	15,2%	14,8%	14,7%	14,7%	**14,1%**
Germany	0,4%	0,2%	2,9%	6,1%	11,1%	12,8%	12,4%	9,6%	**6,9%**
Ireland	2,2%	4,8%	5,4%	4,9%	3,9%	2,6%	2,2%	2,0%	**3,5%**
Italy	0,0%	0,1%	0,3%	0,8%	2,5%	4,8%	7,0%	9,3%	**3,1%**
Netherlands	7,9%	10,7%	0,0%	0,1%	0,6%	1,0%	0,7%	1,1%	**2,8%**
Norway	1,3%	1,6%	1,1%	0,2%	0,2%	0,1%	0,2%	0,3%	**0,6%**
Portugal	4,4%	8,4%	14,2%	19,0%	21,6%	23,8%	23,2%	21,6%	**17,0%**
Spain	0,1%	0,0%	0,1%	0,1%	0,1%	0,1%	0,1%	0,1%	**0,1%**
Sweden	0,6%	0,0%	0,5%	0,3%	0,1%	0,0%	0,2%	0,0%	**0,2%**
Switzerland	0,2%	0,0%	0,0%	0,0%	0,4%	0,6%	0,4%	0,1%	**0,2%**
United Kingdom	0,3%	0,0%	0,0%	2,0%	9,2%	10,2%	1,6%	1,2%	**3,1%**

A general assessment about the influence of the Global Financial Crisis over the YS models can be done through a comparison of the results in tables (i) IS.1 and IS.7, for the IP index and (ii) IS.2 and IS.8 for real GDP. It is important to recall that due to the non-stationary behavior of some series, some models were used taking the YS in its first difference, rather than the level as was the case for other countries. As a consequence, one should relativize simple comparisons involving the R-squared generated by different underlying models.

As a starting point, let us observe the changes in the behavior of the YS-IP models. In comparison to the peer model which incorporates the whole sample period, one can state that, for the majority of the countries, the crisis neither boosted the predictive power of the model nor contribute to worse them. For the other economies, the incorporation of post-2008 changes unequivocally their performance, either for the good or for the bad.

Another outcome brought by the YS-IP models prior to 2008 confirms what was observed for the full sample analysis: for the majority of the countries, the forecasts generated for short time horizons proved to be more accurate than those for more quarters ahead.

The idea that the Financial Crisis had, globally speaking, a neutral effect over the predictive quality of the models should not be extended to the YS-GDP regressions. On the one hand, it is possible to observe the cases of Belgium, and France in which the economic downturn has greatly penalized the models which incorporate real GDP as the dependent variable. In this context, the Portuguese situation is especially remarkable. Prior to 2008, Portugal presented the highest R-squared for a set of time horizons, but the emergence of the worldwide crisis led to a complete collapse of the predictive quality. On the other hand, we can indicate examples that go in the opposite direction: Sweden and Germany have shown to provide more powerful explanatory power when the full sample is taken into account to perform the estimation.

As in the case of the full-sample period, one can also investigate the quality assessment of YS models through the MAD. This indicator is presented in the following tables for the 12 countries and for the 8 time horizons of interest.

Table IS.9 – MAD: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,04	3,52	2,78	2,39	1,94	1,82	1,72	1,70	**2,61**
France	3,14	2,35	2,09	1,87	1,72	1,64	1,51	1,45	**1,97**
Germany	4,74	3,65	3,18	2,93	2,69	2,48	2,36	2,22	**3,03**
Ireland	11,53	7,42	6,23	5,61	4,76	4,58	4,52	4,53	**6,15**
Italy	4,68	3,59	3,10	2,81	2,57	2,36	2,14	1,95	**2,90**
Netherlands	5,69	3,48	2,58	2,15	1,83	1,55	1,38	1,25	**2,49**
Norway	8,27	4,77	3,86	3,27	2,91	2,76	2,76	2,64	**3,91**
Portugal	5,50	3,78	3,16	2,80	2,60	2,36	2,28	2,24	**3,09**
Spain	2,28	2,24	7,24	5,10	4,12	3,70	3,29	3,02	**3,87**
Sweden	2,65	5,74	3,71	3,13	2,66	2,34	2,17	2,04	**3,05**
Switzerland	4,61	3,45	3,14	2,78	2,57	2,36	2,16	1,99	**2,88**
United Kingdom	3,17	2,42	2,14	1,95	1,80	1,72	1,67	1,62	**2,06**

Table IS.10 – MAD: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,83	1,41	1,20	1,06	0,94	0,88	0,79	0,72	**1,10**
France	1,38	1,15	1,02	0,92	0,87	0,82	0,76	0,72	**0,95**
Germany	2,81	1,92	1,56	1,38	1,38	1,30	1,23	1,15	**1,59**
Ireland	5,15	3,44	3,00	2,67	2,52	2,48	2,31	2,22	**2,97**
Italy	1,96	1,56	1,35	1,24	1,14	1,02	0,93	0,85	**1,26**
Netherlands	1,80	1,49	1,27	1,16	1,08	1,06	1,03	1,00	**1,24**
Norway	3,87	2,10	1,75	1,50	1,27	1,17	1,09	1,05	**1,73**
Portugal	3,09	2,17	1,86	1,73	1,60	1,54	1,50	1,46	**1,87**
Spain	1,50	1,46	1,93	1,66	1,54	1,46	1,37	1,30	**1,53**
Sweden	2,81	2,07	1,86	1,72	1,56	1,49	1,40	1,36	**1,78**
Switzerland	2,15	1,50	1,32	1,27	1,18	1,16	1,12	1,10	**1,35**
United Kingdom	1,93	1,65	1,44	1,28	1,16	1,08	1,01	0,98	**1,32**

Before focusing properly on the effects of the economic collapse that started in 2008, it is interesting to notice that, alike to what was noticed in the full sample examination, the models using real GDP as the dependent variable provide a greater average forecasting error when compared with those which use the IP index.

If the analysis of the R-squared does not demonstrate a clear striking effect of the 2008-Crisis over the reliability of the YS models for the sample, the same cannot be said when the forecasting errors are considered. Disregarding the period after 2008 leads to a substantial reduction in the MADs for all the countries analyzed, regardless of the manner one wishes to measure future economic activity.[7]

If on the one hand, the Global crisis has contributed to ruin the predictive strength of the model, on the other, it has presented some sign of preservation. For instance, a comparison between each YS model with its similar for the full sample enables one to conclude that (i) there were no significant changes in the overall relative performance across countries; (ii) the model has demonstrated to be less erratic for the regressions that aim at predicting economic growth for 8 quarters ahead and (iii) Ireland has shown to be by far the economy with the poorest performance.

As in the case of the full sample analysis, one may be interested in establishing a performance ranking based on the different assessment tools in order to compare whether they influence countries' relative positions. Results are shown in the tables IS.11 and IS.12.

As a general feature, it is possible to remark that, there are significant changes in the relative position of the countries from one ranking to the other, and, these variations have shown to be rather drastic in the cases such as Portugal, Ireland and the UK. Additionally, one observes that, out of the 12 economies, only Belgium and France top performed in both indicators, whereas only Spain and Norway have demonstrated to be among very low reliability of the YS models.

[7] The only relevant exception to that is Sweden, when one observes the predictions for up to 2 quarters ahead.

Table IS.11 – MAD: Average of YS models – Prior to 2008

France	1,46
United Kingdom	1,70
Belgium	1,86
Netherlands	1,88
Italy	2,08
Switzerland	2,15
Germany	2,31
Sweden	2,33
Portugal	2,48
Spain	2,70
Norway	2,80
Ireland	4,56

Table IS.12 – R-Squared: Average of YS models – Prior to 2008

Belgium	21,4%
Portugal	19,1%
France	11,7%
Sweden	4,7%
Germany	3,7%
Netherlands	3,6%
Ireland	2,1%
Italy	2,1%
United Kingdom	1,7%
Norway	0,5%
Switzerland	0,5%
Spain	0,3%

The crisis also exerted significant influence over the slope coefficients, as observed in the appendix B. As it was explained in section 2, one may expect a positive signal for the coefficients $\alpha_1's$. This theoretical prediction, however, is not empirically confirmed for a high number of countries when the whole period of estimation is set[8], even though the contrary is commonly verified for prior-2008. Besides the inversion in the signal, one can also highlight an ambiguous effect of the crisis over their magnitude: when the model is estimated for the sample that includes the period after 2008, a given change in the yield spread impacts significantly the expected future economic growth, but the sign of the variation is far from being unanimous.

4.2.3) Comparison with other benchmarks

Presented a general assessment about the forecast quality of a model that assumes the YS as the only explanatory variable, one may be interested in comparing these results with the

[8] The signal is particularly puzzling for the case of France: regardless the dependent variable chosen and the sample period taken into account, the models has often presented a combinations of negative coefficients and a rather high t-statistics, which is an argument to in favor of the significance of the coefficient.

performance of alternative models. To be consistent with the choice widely disseminated in the literature, we are adopting the following benchmarks: a pure autoregressive models (AR, hereafter), a autoregressive combined with the yield spread (AR + YS, hereafter) and a Random Walk model (RW, hereafter). The order of the AR was chosen to be equal to 1 for both cases. In particular, the outcomes of interest will be derived from the following regressions:

AR Model $$g_{t\to t+k} = \alpha_0 + \alpha_1 g_{t\to t+k-1} + \varepsilon_{t+k} \qquad (4.4)$$

RW Model $$g_{t\to t+k} = g_{t\to t+k-1} + \varepsilon_{t+k} \qquad (4.5)$$

AR + YS Model $$g_{t\to t+k} = \alpha_0 + \alpha_1 YS_t + \alpha_2 g_{t\to t+k-1} + \varepsilon_{t+k} \qquad (4.6)$$

The model 4 was estimated in first difference for the cases in which the YS has demonstrated evidences of non-stationarity.

In this section, our objectives are twofold. Firstly, as *per se* in Haubrich and Dombrosky (1996) and Bonser-Neal and Morley, 1997), it is of our interested to observe how powerful the YS model can be in comparison to the others. Secondly, following Berk and Bergeijk (2000) and Sedillot (2001), we intend to assess whether the YS can contribute to enhance the predictive power of specifications containing information about past economic activity.

In order to make the analysis tractable, it was decided to compute, as a metric of summarizing results, just the average of all time horizons for both the R-Squared and the forecasting errors (the detailing description of the outcomes separated per quarter can be found in the appendix C[9]). The separation between the two periods of interest was maintained, though.

[9] It was decided to report the tables for the MAD, only, as we believe that the general features of the R-Squared do not change significantly across models. However, one can retrieve these outcomes on request from the author.

It is also relevant to highlight that the tables IS.13 and IS.14 show the Adjusted R-squared - rather than the conventional R-Squared – for both AR and AR + YS models[10]. Thanks to this procedure, we can directly observe net predictive contribution of the YS in the AR framework here studied.

Table IS.13 - Comparison of Several models for the whole period: Average of all time horizons – Estimated R-squared[11]

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	17,1%	10,2%	52,3%	65,5%	0,0%	0,0%	49,7%	60,7%
France	10,8%	10,6%	66,5%	76,2%	0,0%	0,0%	62,4%	71,6%
Germany	26,8%	10,9%	63,4%	58,6%	0,0%	0,0%	61,9%	54,0%
Ireland	5,7%	2,3%	51,8%	68,5%	0,0%	0,0%	47,0%	59,6%
Italy	0,4%	0,1%	68,0%	72,5%	0,0%	0,0%	62,3%	66,3%
Netherlands	4,2%	5,6%	34,6%	63,9%	0,0%	0,0%	33,9%	69,0%
Norway	3,4%	5,1%	39,3%	44,4%	0,0%	0,0%	36,4%	38,4%
Portugal	1,0%	1,7%	60,0%	67,0%	0,0%	0,0%	54,2%	60,7%
Spain	0,5%	0,3%	48,7%	69,6%	0,0%	0,0%	43,0%	63,7%
Sweden	10,7%	34,5%	61,8%	57,8%	0,0%	0,0%	63,9%	64,3%
Switzerland	0,5%	0,2%	73,2%	73,4%	0,0%	0,0%	67,4%	65,4%
United Kingdom	4,6%	5,6%	66,9%	77,8%	0,0%	0,0%	63,9%	75,2%

From the next tables, it is possible to notice that the AR model, often, demonstrates a slightly better fit when the adjustment the number of regressors is taken into account. This conclusion holds for both periods and for both choice of dependent variables. Therefore, in accordance with the studies of Berk and Bergeijk (2000) and Sedillot (2001), we conclude that the YS does not add on relevant predictive content to the AR model.

[10] The same procedure was not adopted for the YS and the RW models, as it seems already evident the huge discrepancy in performance between (i) YS and RW models and (ii) AR(1) and AR(1)+YS (recall that the R-Squared always assume values that are, at least, as great as the adjusted R-squared).
[11] Adjusted R-Squared values shown for both AR(1) and YS+AR(1) models.

Table IS14- Comparison of Several models for Prior-2008: Average of all time horizons - Estimated R-squared[11]

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	24,0%	18,9%	53,1%	66,0%	0,0%	0,0%	50,1%	61,6%
France	9,4%	14,1%	71,6%	78,3%	0,0%	0,0%	66,9%	73,9%
Germany	0,4%	6,9%	67,6%	60,5%	0,0%	0,0%	61,8%	53,7%
Ireland	0,8%	3,5%	68,5%	67,3%	0,0%	0,0%	47,0%	58,7%
Italy	1,1%	3,1%	72,5%	68,5%	0,0%	0,0%	65,5%	66,1%
Netherlands	4,3%	2,8%	36,2%	61,8%	0,0%	0,0%	37,0%	65,8%
Norway	0,4%	0,6%	36,8%	44,9%	0,0%	0,0%	35,7%	40,2%
Portugal	21,2%	17,0%	67,0%	72,5%	0,0%	0,0%	57,8%	59,4%
Spain	0,5%	0,1%	69,6%	71,3%	0,0%	0,0%	45,1%	65,2%
Sweden	9,2%	0,2%	63,1%	58,6%	0,0%	0,0%	62,4%	61,2%
Switzerland	0,8%	0,2%	74,1%	68,9%	0,0%	0,0%	68,4%	60,7%
United Kingdom	0,4%	3,1%	68,6%	78,7%	0,0%	0,0%	66,5%	76,7%

Regarding the relative performance of the YS model before the benchmarks, we clearly observe that the YS showed to be rather inferior. Even though the YS beats by far the RW model, it does extremely worse than the other models. Not even when the YS has achieved its highest explanatory power among all the countries (*i.e.* when the dependent variable is GDP for Sweden in the whole period assessment and Belgium, IP for the prior 2008 period), the model indicate a comparable result.

It is interesting to point out that the overall performance of the models measured as the (adjusted) R-squared does not seem to be affected greatly by the global financial crisis. The only exception to this rule is the AR- IP model for Spain: the emergence of the worldwide collapse has trimmed the explanatory power of the model.

Table IS.15- Comparison of Several models for the whole period: Average of all time horizons – MAD

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	3,12	1,24	2,34	0,76	2,75	0,83	2,27	0,75
France	2,42	1,07	1,57	0,55	1,74	0,59	1,54	0,54
Germany	3,36	1,64	2,19	1,11	2,44	1,28	2,15	1,09
Ireland	6,35	3,67	4,37	1,69	5,17	1,81	4,63	2,01
Italy	3,62	1,78	2,10	0,81	2,32	0,87	2,09	0,88
Netherlands	2,93	1,62	2,70	0,98	3,39	1,10	2,49	0,77
Norway	4,29	1,82	3,46	1,54	4,38	1,96	3,43	1,48
Portugal	3,74	2,25	2,46	1,30	2,88	1,44	2,37	1,23
Spain	4,04	1,67	2,89	0,79	3,41	0,84	2,88	0,78
Sweden	3,66	1,62	2,62	1,24	2,99	1,47	2,51	1,10
Switzerland	3,51	1,93	1,91	0,82	2,09	0,87	1,92	0,84
United Kingdom	2,33	1,65	1,42	0,79	1,58	0,86	1,30	0,76

Table IS.16 - Comparison of Several models for Prior-2008: Average of all time horizons - MAD

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	2,61	1,10	2,28	0,77	2,71	0,85	2,21	0,76
France	1,97	0,95	1,52	0,54	1,64	0,57	1,50	0,54
Germany	3,03	1,59	2,11	1,13	2,71	4,10	2,07	1,12
Ireland	6,15	2,97	4,32	1,71	5,18	1,79	4,57	2,04
Italy	2,90	1,26	2,08	0,80	2,25	0,86	2,08	0,80
Netherlands	2,49	1,24	2,63	1,31	1,64	2,78	2,38	0,74
Norway	3,91	1,73	3,26	1,00	2,27	3,54	3,20	1,47
Portugal	3,09	1,87	2,40	1,30	2,78	1,46	2,29	1,23
Spain	3,87	1,53	2,94	0,79	3,46	0,84	2,91	0,78
Sweden	3,05	1,78	2,55	1,30	5,18	2,91	2,45	1,14
Switzerland	2,88	1,35	1,91	0,83	2,25	2,06	1,89	0,81
United Kingdom	2,06	1,32	1,42	0,81	3,27	1,55	1,28	0,78

The assessment of the relative strength of the YS model does not suffer major changes when one analysis the MAD (see previous tables). When the comparison is made taking into account the full sample, it becomes evident the significant gap existent between the performance of the YS model and all the other benchmarks. The figure changes considerably when the estimation is made for the period until 2008. At this stage, the YS has presented more consistent achievements than the RW in one third of the cases, being a fairly superior achievement noticed for the case of Sweden. Nevertheless, when confrontation is made for both AR and AR+YS, one can still remark that the YS still falls short – contradicting the findings of Haubrich and Dombrosky (1996) for the USA, when an in-sample estimation is carried out.

It is also expressive the behavior of the YS in the lagged output framework. Out of the 48 cases (*i.e.* for all countries, both dependent variables and sample periods), the YS improved the predictive power of the AR model in only 7 occasions.

4.2.4) Diebold-Mariano test

In order to verify whether the difference in accuracy of the forecasts generated by the YS and the other models is statistically significant, one performed the test proposed by Diebold and Mariano (1995). This test is conducted from a time-t loss differential function defined as $\mathrm{d}_{\mathrm{ij;t}} = e_{\mathrm{it}}^2 - e_{\mathrm{jt}}^2$, *i.e.*, the difference of the quadratic forecasts errors between models *i* and *j* at time t. The null hypothesis assumes that both models have the same predictive accuracy. In other words, one wishes to test whether the time-t loss differential function has expected value equal to zero or $\mathrm{E}(\mathrm{d}_{\mathrm{ij;t}}) = 0$. Assuming the null as true, one can build the Diebold Mariano (DM) statistic:

$$DM_{ij} = \frac{\overline{d_{ij}}}{\hat{\sigma}_{\overline{d_{ij}}}} \rightarrow \mathrm{N}(0,1)$$

where the $\bar{d}_{ij} = \sum_{t=1}^{T} \mathrm{d}_{\mathrm{ij;t}}$ can be defined as the mean of the loss differential observations and $\hat{\sigma}_{\overline{d_{ij}}}$, a consistent estimator of its standard deviation. The last term was computed through the procedure suggested by Newey and West (1987), which provides robust standard errors for heteroskedasticity and autocorrelation.

Satisfied these conditions, the DM statistic will follow a standard Normal distribution. In this manner, by running an OLS regression (with Newey-West standard errors) of the loss differential function on an intercept and observing its t-statistic, one can draw conclusions about the difference in forecasts accuracy between models (see Diebold, 2014). Low values of t-statistic/DM favor the veracity of the null hypothesis and, hence, suggest that models provide, on average, the level of accuracy, whereas high values of t-statistic/DM demonstrate evidences that one of the models often provides more proper forecasts than the other.

The Diebold-Mariano test was made to compare the performance of the YS model - for every countries, time horizons and historical period - before the benchmarks. Table DM.1 presents a summary result about the frequent in which the rejection of the null hypothesis was confirmed, assuming a level of significance of 10%.

Table DM.1 – Frequency of discrepancy in accuracy prediction: comparison between the YS model and the benchmarks - Diebold-Mariano test (Level of significance: 10%) [12]

	Whole Period		Prior 2008	
	IP	**GDP**	**IP**	**GDP**
YS x AR(1)	45%	70%	36%	50%
YS x RW	45%	70%	36%	53%
YS x AR(1)+YS	46%	70%	36%	53%

The previous table corroborates the preceding conclusion that the forecasts obtained from the YS model are often less accurate than the other models tested. By way of illustration, for the full sample case that considers the GDP as the dependent variable, one remarks that the YS has presented less precise predictions in about 70% of the cases; a result that showed to be statistically significant. As it was also noticed in the analysis of tables IS.15 and IS.16, the

[12] The critical values of the t-statistic used was $t_c = 1,66$

gap in the performance of the YS is less prominent when the period after 2008 is included in the sample.

A similar exercise was performed to assess the difference in forecasting accuracy between the AR and the AR +YS. The outcomes were not surprising, if we take into consideration the small divergence in the values of the MADs in tables IS.15 and IS.16: in none of the 192 cases tested, the YS showed to improve the forecasts of the autoregressive model.

4.2.5) In-Sample: The best fit that the YS models can achieve

Having analyzed the performance of models with different dependent variables, time horizons forecasting periods and after a drastic overturn in the macroeconomic environments, one can clearly conclude that the YS model has rather limited capability of prediction for an individual set of European countries – the same conclusion was reached by Berk and van Bergeijk (2000) for an aggregate of the Euro Area. In spite of that, one may wish to observe at which configurations of dependent variable, time horizon and historical period the YS model yields the highest explanation power. The table IS.17, which summarizes these outcomes, was built by a simple observation of the regressions with the greatest R-squared[13].

[13] It was decided to not include MAD in this analysis due to the lack of variability in the results across countries. As it is possible to deduct from what was exposed in the previous sub-sections, the "best" model for every country would be the one which focus on the pre-crisis period, which has the Real GDP as the depend variable and favors forecasts of long-horizon.

Table IS.17 – Models with the best fit, per country

	Dependent Variable	Period	Best time horizon
Belgium	IP	Prior to 2008	Medium + Long
France	GDP	Prior to 2008	Medium
Germany	IP	Whole period	Medium + Long
Ireland	IP	Whole period	Medium + Long
Italy	GDP	Prior to 2008	Long
Netherlands	GDP	Whole period	NONE
Norway	GDP	Whole period	Long
Portugal	IP	Prior to 2008	Medium + Long
Spain	NONE		
Sweden	GDP	Whole period	Medium
Switzerland	NONE		
United Kingdom	GDP	Whole period	Medium

Several are the interesting aspects to be highlighted. Firstly, there is no clear evidence if the yield spread is a more reliable leading indicator of real economic activity when this one is measured either as IP or as real GDP. Secondly, the poor predictive power of the framework analyzed should not be assigned to the last financial crisis. Thirdly, the models achieve peak of their performance as of a medium time horizon (*i.e*, of 1-year ahead) and performs quite badly for shorter periods (See table B5, in the appendix B). The same conclusion is reached by Passaro (2007) for Germany and the USA and Nobili (2005) for countries of the Euro Area as an aggregate. Hamilton and Kim's (2002) finding for the USA that that the model starts losing predictive power after 8 quarters in the future is not confirmed by most of the economies here studied. Finally, the yield spread indicator does not convey any useful information about Spain's and Switzerland's future economic growth (in all of the 32 regressions estimated, the R-squared barely overcomes 1%).

4.3) Out-of-sample estimation

Having extensively investigated the strength of the predictive power of the Yield Spread for the in-sample procedure, one is going to assess the general performance of the model *vis-à-vis* to the same benchmarks of the previous section 4.2, but, this time, for an out-of-sample estimation.

In the out-of-sample framework, the regressions take into consideration only the information that was available at the moment - rather than the entire set of historical information (full sample), as it is typically done in the in-sample estimation - that the forecasting was conducted. In particular, for the YS model, one has computed the following equation:

YS' model $$g_{t \to t+k} | I_t = \beta_0 + \beta_1 YS_t + \varepsilon_{t+k} \qquad (4.1)''$$

where I_t corresponds to the set of information available up to time t. It is important to highlight that for all the models, the information set was decided to start in 1996Q4 and, hence, the forecasts begun from the first quarter of 1997.

As it was done for the in-sample analysis, one resorted to both R-Squared and MAD as assessment tools of YS model's predictive quality.

A word of caution is needed for the case of the R-Squared. Due to the fact that the forecasts of a given time horizon are generated by different models as time goes by (the parameters of the model are re-estimated as a new information becomes available), the R-Squared may assume negative values - feature that is impossible in our in-sample estimation[14] - when the fit values of the estimated model perform worse than the sample mean. As a result of that, electing the estimation procedure (in and out of-sample) that yields the best fit becomes a meaningless task. However, one can still compute the R-Squared as a manner of establishing comparisons across countries within a certain period and to observe their behavior after the global of Crisis 2008. The outcomes of these estimations are provided by the following tables.

[14] A linear model estimated by OLS containing an intercept and subject to no constraints must always provide a positive (or zero) value. See Wooldridge (2009).

Table OS.1- Comparison of Several models for the whole period: Average of all time horizons – Estimated R-squared

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	44,4%	38,5%	52,3%	84,2%	58,7%	84,3%	64,9%	82,1%
France	43,0%	32,6%	66,5%	85,9%	72,6%	84,9%	69,9%	83,3%
Germany	50,3%	44,4%	63,4%	81,1%	70,4%	80,0%	71,0%	79,8%
Ireland	19,9%	32,4%	51,8%	70,0%	51,4%	59,4%	60,6%	61,2%
Italy	27,6%	25,3%	68,0%	83,8%	76,9%	84,2%	72,3%	80,3%
Netherlands	39,0%	48,7%	34,6%	86,6%	56,4%	89,1%	65,7%	86,8%
Norway	55,8%	42,1%	39,3%	77,3%	61,9%	67,9%	69,0%	73,8%
Portugal	43,7%	52,0%	60,0%	87,0%	73,1%	85,6%	77,1%	82,9%
Spain	53,1%	32,5%	48,7%	85,5%	57,7%	83,9%	64,7%	83,2%
Sweden	62,6%	37,9%	61,8%	80,9%	77,1%	79,6%	76,7%	82,0%
Switzerland	38,5%	28,5%	73,2%	91,3%	83,2%	95,6%	80,2%	88,0%
United Kingdom	-0,6%	40,6%	66,9%	1,4%	83,9%	1,5%	82,7%	1,2%

Table OS.2 - Comparison of Several models for Prior to 2008: Average of all time horizons - Estimated R-squared

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	61,8%	71,1%	72,4%	88,6%	63,2%	88,8%	71,3%	87,9%
France	64,2%	68,4%	83,7%	89,7%	81,2%	89,0%	82,6%	88,0%
Germany	62,8%	69,7%	84,4%	88,5%	83,6%	88,2%	83,2%	87,8%
Ireland	42,6%	45,7%	67,7%	65,8%	51,2%	51,3%	63,1%	60,7%
Italy	64,4%	60,6%	84,5%	87,5%	82,4%	86,8%	83,0%	85,8%
Netherlands	69,9%	66,3%	75,2%	90,7%	67,8%	92,4%	74,9%	90,9%
Norway	53,8%	77,9%	78,0%	82,9%	75,0%	75,2%	78,4%	82,4%
Portugal	65,7%	63,8%	86,3%	90,1%	82,0%	87,3%	84,8%	86,9%
Spain	37,7%	65,3%	71,6%	90,7%	62,3%	90,2%	68,6%	89,3%
Sweden	71,9%	65,0%	83,8%	89,3%	81,0%	88,5%	83,7%	89,2%
Switzerland	58,0%	75,8%	87,5%	94,0%	87,3%	95,4%	85,7%	93,2%
United Kingdom	67,4%	73,0%	90,0%	90,3%	90,3%	90,6%	90,2%	89,8%

Implementing the out-of-sample estimations does not change substantially the relative ranking of the YS over the other models tested as it continues to demonstrate worse results when compared with the top-performers. However, one may argue that the new estimation procedure has contributed to enhance greatly the performance of the YS model, softening the disparity with the benchmarks. This fit gain is especially meaningful when the regressions are run until the year of 2008 (more on that in the next subsection).

It is also interesting to notice that the lack of an evident of a “winner” model. Besides presenting rather similar R-Squared values in general, the RW, the AR and the YS+AR switch up in the first position, depending on the country, the estimation period and the choice of the dependent variable. The fact that the AR+YS presented an eventual superior performance in the full-sample than the AR evidences that the YS can play a better when the estimation made is out-of-sample than in-sample.

Table OS.3 - Comparison of Several models for the whole period: Average of all time horizons - MAD

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	3,88	1,38	2,79	0,72	3,06	0,72	2,72	0,73
France	2,75	1,21	1,82	0,57	1,93	0,60	1,76	0,57
Germany	3,92	1,70	2,55	0,98	2,68	1,03	2,42	0,97
Ireland	7,64	4,31	5,37	2,52	6,38	2,83	5,44	2,58
Italy	4,17	1,80	2,32	0,84	2,38	0,85	2,33	0,84
Netherlands	3,19	1,94	2,77	0,88	3,27	0,82	2,76	0,84
Norway	5,01	1,85	3,69	1,41	4,29	1,72	3,69	1,46
Portugal	3,65	2,50	2,50	1,19	2,88	1,24	2,46	1,21
Spain	4,70	1,39	3,31	0,74	3,74	0,77	3,33	0,74
Sweden	3,94	1,64	2,77	1,18	2,96	1,29	2,67	1,09
Switzerland	3,72	1,94	1,99	0,74	2,10	0,60	1,91	0,67
United Kingdom	2,69	6,50	1,39	5,54	1,43	5,56	1,36	5,53

Table OS.4- Comparison of Several models for Prior-2008: Average of all time horizons - MAD

	YS		AR(1)		RW		YS+AR(1)	
	IP	GDP	IP	GDP	IP	GDP	IP	GDP
Belgium	3,01	1,05	2,77	0,76	3,06	0,75	2,72	0,76
France	1,83	0,91	1,71	0,57	1,76	0,57	1,67	0,57
Germany	3,10	1,44	2,34	1,01	2,35	0,98	1,85	0,87
Ireland	7,34	3,51	5,56	2,78	6,83	3,13	5,61	2,81
Italy	2,61	1,21	2,24	0,83	2,23	0,82	2,26	0,83
Netherlands	2,55	1,37	2,62	0,83	2,94	0,73	3,10	1,30
Norway	4,43	1,46	3,23	1,36	3,60	1,62	2,38	0,72
Portugal	3,29	2,01	2,35	1,14	2,66	1,21	2,33	1,18
Spain	5,18	1,42	3,74	0,72	4,13	0,70	3,73	0,72
Sweden	2,50	1,75	2,58	1,18	2,72	1,22	2,11	0,97
Switzerland	2,57	1,06	1,87	0,62	1,92	0,53	1,51	0,53
United Kingdom	2,04	1,06	1,35	0,83	1,32	0,81	1,10	0,73

The analysis of the MAD holds some similarities with the one made for the R-Squared. Firstly, the global crisis of 2008 has exerted a negative influence over the predictive quality of the YS model. Secondly, for both estimation periods considered, the YS is the model with the least accuracy. The novelty regarding the previous analysis lies in the general lack of predictive gain of the YS when incorporated in the AR model.

As a manner of assessing whether this difference in performance presents statistical relevance, one has computed the Diebold-Mariano test (see the following table).

Table DM.2 – Frequency of discrepancy in accuracy prediction: comparison between the YS model and the benchmarks - Diebold-Mariano test (Level of significance: 10%)[15]

	Whole Period		Prior 2008	
	IP	GDP	IP	GDP
YS x AR(1)	41%	44%	65%	74%
YS x RW	41%	44%	65%	74%
YS x AR(1)+YS	41%	44%	65%	74%

It is interesting to notice that the rejection of the null hypothesis –implying that the models tested do not present the same expected forecasting error - has shown to be more frequent in period preceding the Global Crisis, which exactly when the YS model achieves its best outcomes. Furthermore, one can remark that the difference in the accuracy of forecasts is marked for the cases in which the real GDP is assumed as the explanatory variable.

When one compares the Diebold-Mariano test performed above with the one made for the in-sample estimation, it is possible to conclude that the YS model has presented a dubious behavior. On the one hand, when the whole period is considered, the out-of-sample estimation has proven a better forecasting capability relatively to the other models (*i.e.*, the null was rejected less often). On the other hand, the figure reverses when one observes the period prior-

[15] The critical values of the t-statistic used were: (i) t_c = 1,664 for the whole period (ii) and t_c = 1,671 for the period prior to 2008.

2008: at this stage, the in-sample estimation provides more favorable results for the YS model.

An assessment of the conduct of the MAD in the YS model over both in and out of sample estimations also leads to ambiguous results. For the full sample, the forecasting errors of the in-sample models are smaller than those of the out-of-sample in approximately in 92% of the cases. In contrast to that, by excluding the period 2009 through 2013, one observes a slightly advantage of the out-of-sample estimations: 56% against 44%.

4.3.1) Out-of-Sample: The best fit that the YS models can achieve

Similarly to what was done for the in-sample framework (see subsection 4.2.5), one will examine whether the YS models present common features across countries when the R-Squared are analyzed at their top-performance.

Table OS.5 – Models with the best fit, per country

	Dependent Variable	Period
Belgium	GDP	Prior to 2008
France	GDP	Prior to 2008
Germany	GDP	Prior to 2008
Ireland	GDP	Prior to 2008
Italy	IP	Prior to 2008
Netherlands	IP	Prior to 2008
Norway	GDP	Prior to 2008
Portugal	IP + GDP	Prior to 2008
Spain	GDP	Prior to 2008
Sweden	IP	Prior to 2008
Switzerland	GDP	Prior to 2008
United Kingdom	GDP	Prior to 2008

In opposition to the in-sample analysis based on table IS.17, the out-of-sample procedure leads to less blurred results. In the first place, it is quite visible the harmful effects that the last worldwide financial downturn has generated over the fit quality of the YS model. Secondly, the YS has shown to act better as a leading indicator for the real GDP than for the IP index.

So far, no references were made about the fit quality according to the different time horizons. The reason for that becomes clear when one observes the table D.1 (available at the appendix D). Electing for which time horizons the model works the best becomes a critical task, as no major variations through time can be observed on the R-Squared values. However, it seems fair to state that the worst forecasts fits are especially found up to 1-year ahead, alike to what was pointed out for the in-sample estimation.

5- Concluding Remarks

The focus of this study was facing to scrutinize the degree of reliability of the YS in anticipating future economic activity for set of European countries. To this end, a model containing the Yield Spread as the only covariate was tested for different historical periods, dependent variables, time horizons and estimation procedures. Even though we found that the strength of YS-growth relationship varies considerably from country to country, we were able to identify some common general features.

Our analysis for both in and out-of-sample estimations revealed that the YS fails to act as good indicator of economic growth, regardless the choices of dependent variable and the time horizon forecasts. We also remarked that blaming the Global Financial Crisis of 2008 for the poor achievements of the models containing the YS is an overstatement, but assigning it some responsibility for performance fading is legitimate.

The unsatisfactory performances of the YS models became more evident when they were confronted with alternative specifications. Besides presenting lower quality in terms of fit (R-Squared), the YS model, according to the Diebold-Mariano test, also provided frequently forecasts of inferior quality than the other benchmarks. Moreover, corroborating the finding of previous studies (*e.g.* Sedillot, 2001 and Berk and Van Bergeijk, 2000), we also verify that the YS does not contribute over-and-above to models containing information about past output.

Notwithstanding the overall poor predictive attributes of the term spread, we searched for possible common features among the YS models when they reached their top performance. Our conclusions were twofold. First, we observed that, roughly speaking, the YS can predict better the real GDP than the IP index. Second, the best estimation procedure depends on the period of analysis: while for the whole period the in-sample estimations provide more accurate forecast, when one excludes the time spam 200-2013, the out-of-sample method demonstrate a superior performance.

Duarte, Venetis and Payá (2004) suggested that the predictive content of the YS can be enhanced through the use of nonlinear techniques for the European Union as a whole in a sample period comprised up to the year 2000. It would be an interesting topic for future research to test whether this conclusion can be extended for a disaggregate level of countries, including the consolidation period of the Monetary Union.

References

Ang, A., Piazzesi, M., & Wei, M. (2006). What does the yield curve tell us about GDP growth? *Journal of Econometrics*, *131*, 359-403.

Berk, J.N., & Van Bergeijk, P. (2000). Is the yield curve a useful information variable for the eurosystem? *European Central Bank. Working Paper Series*, *(11)*, 25.

Bonser-Neal, C., & Morley, T.R. (1997). Does the Yield Spread Predict Real Economic Activity? A Multicountry Analysis. *Federal Reserve Bank of Kansas City*, 37-53.

Bueno, R. de D. da S (2008). *Econometria de Séries Temporais*. Cengage, São Paulo.

Diebold, F.X. (2014). Comparing Predictive Accuracy, twenty years later: A personal perspective on the use and abuse of Diebold-Mariano test. *Journal of Business and Economic Statistics*, 23.

Diebold, F.X., & Mariano, R. S. (1995). Comparing Predictive accuracy. *Journal of Business Economics Statistics*, *13*, 253-256.

Dotsey, M. (1997). The Predictive Content of the Interest Rate Term Spread for Future Economic Growth. *Federal Reserve Bank of Richmond, 84/3*, 31-51.

Duarte, A., Venetis, I.A. & and Payá, I. (2004). Predicting real growth and the probability of recession in the euro area using the yield spread. *Instituto Valenciano de Investigaciones Económicas, S.A.*, 32.

Estrella, A. (1997).Why do interest rates predict macro outcomes? A unified Theory of Inflation, Output, interest and Policy. F*ederal Reserve Bank of New York. Research Paper Number 9717*, 36.

Estrella, A. (2005). Why does the yield curve predict output and inflation? *The Economic Journal*, *115*, 722-744.

Estrella, A., & Hardouvelis, G.A. (1991). The term structure as a predictor of Real Economic Activity. *The Journal of Finance*, 46 (2), 555-575.

Estrella, A., Rodrigues, A.P. & Schich, S. (2000). How stable is the predictive power of the yield curve? Evidences from Germany and the United States. F*ederal Reserve Bank of New York, number 13*, 32.

Hamilton, J.D., & Kim, D. H. (2002). A reexamination of the predictability of the yield spread for real economic activity. *Journal of Money, Credit and Banking, 34 (2)*, 340-360.

Harvey, C.R. (1988). The real term structure and consumption growth. *Journal of Financial Economics, 22*, 305-333.

Haubrich, J., & Dombrosky, A. (1996). Predicting Real Growth Using the Yield Curve. *Federal Reserve Bank of Cleveland, Economic Review*, 26-35.

Hu, Z. (1993). The Yield Curve and Real Activity. *International Monetary Fund Staff Papers, 40(4)*, 781-806.

Moneta, F. (2003). Does the yield spread predict recession recession in the euro area? *European Central Bank. Working Paper Series,* 294, 59`.

Newey, W.K. & West, K.D. (1987). A simple, positive Semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix. *Econometrica*, 55 (3), 703-708.

Nobili, A. (2005). Forecasting output growth and inflation in the euro area: are financial spreads useful? *Banca D'Italia, Temi di Discussione*, Number 544, 58.

Passaro, R. (2007). The predictive power of the interest rate spread for economic activity. *Rivista di Politica Economica*, November-December, 81-111.

Sedillot. F. (2001). La pente des taux contient-elle de l'information sur l'activité économique future? *Economie & Prevision*, 147, 141-157

Stock, J. H., & Watson, M.W. (1989). New indexes of coincident and Leading economic indicators. Blanchard, O. J. & Fisher, S., eds: *NBER Macroeconomics Annual 1989*. MIT Press, Cambridge, 4, 351-393.

Wheelock, D. C., &.Wohar, M. E. (2009). Can the term spread predict output growth and recessions? A Survey of the Literature. *Federal Reserve Bank of St. Louis Review,* 91(5, Part I), 419-440.

Wooldridge, J. F. (2009). *Introductory econometrics: A modern approach*. 4th ed.,South Western College Publishing.

Appendix A – General features

Table A.1- Period of analysis - per country

Country	Starting date	Final date
Belgium	1980Q1	2013Q4
France	1980Q1	2013Q4
Germany	1980Q1	2013Q4
Ireland	1988Q4	2013Q4
Italy	1980Q1	2013Q4
Netherlands	1986Q2	2013Q4
Norway	1985Q1	2013Q4
Portugal	1986Q1	2013Q4
Spain	1980Q1	2013Q4
Switzerland	1980Q1	2013Q4
Sweden	1987Q1	2013Q4
United Kingdom	1984Q1	2013Q4

Chart A.1: Yield Spread: Historical Evolution – Set of countries (Part I)

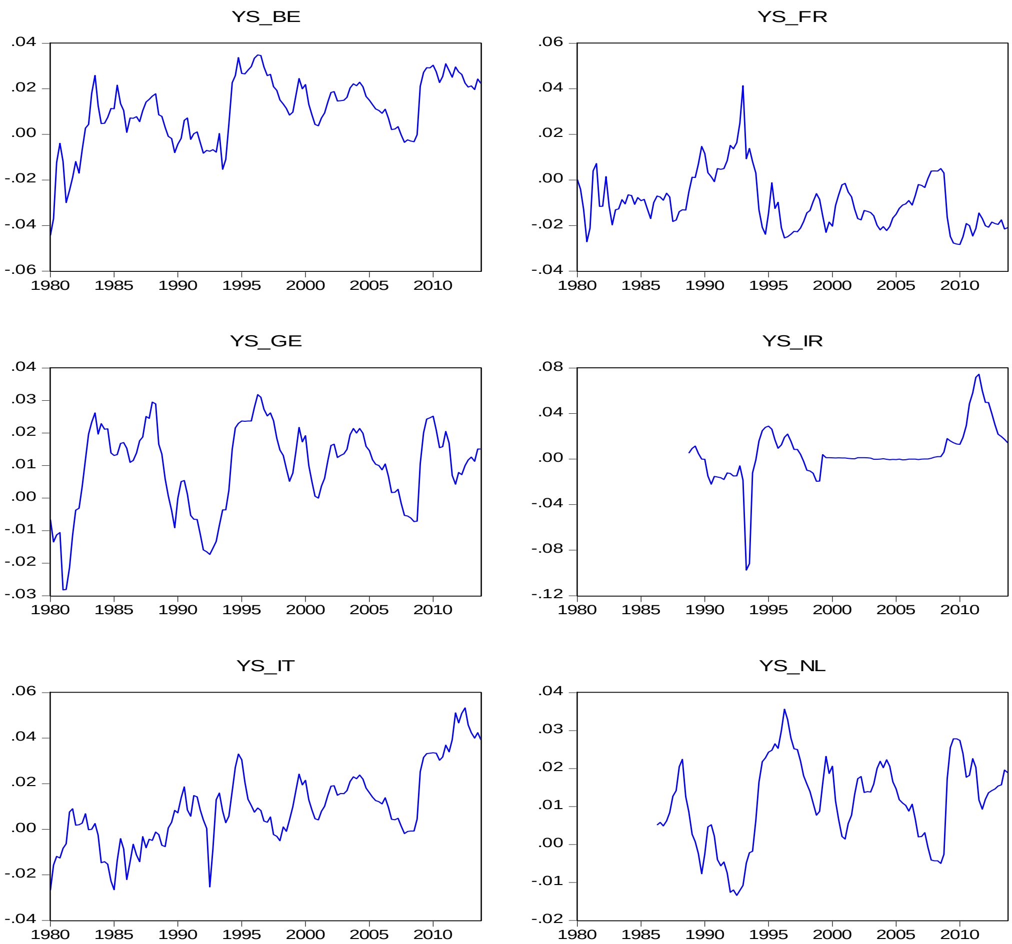
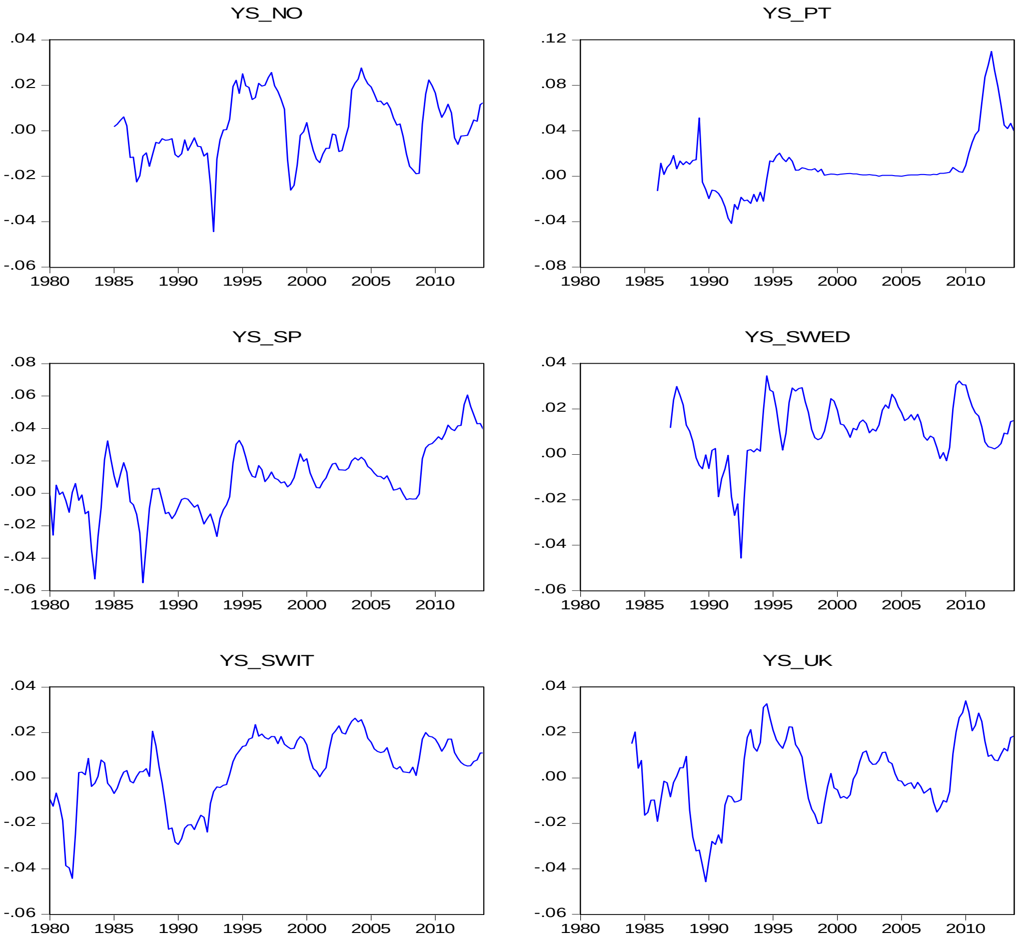


Chart A.2: Yield Spread: Historical Evolution – Set of countries (Part II)



Appendix B – In-Sample analysis

Table B.1 - Estimated Slope Coefficient (α_1) of the YS model for different time horizons –Whole period
Dependent variable: Industrial Production *

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	165,54 (51,241)	154,1 (48,324)	149,31 (43,668)	130,59 (38,779)	114,4 (34,776)	98,93 (30,816)	87,96 (27,156)	81,98 (24,113)
France	-140,92 (60,402)	-134,17 (61,79)	-126,27 (59,905)	-116,96 (58,484)	-104,75 (57,199)	-89,23 (52,946)	-75,5 (48,483)	-67,12 (44,158)
Germany	246,18 (81,236)	242,08 (77,36)	229,52 (70,117)	220,13 (62,588)	210,17 (54,739)	195,55 (46,154)	179,86 (38,997)	164,98 (33,698)
Ireland	-43,27 (47,098)	-57,52 (40,419)	-67,93 (35,248)	-65,59 (33,212)	-70,22 (31,751)	-77,59 (29,183)	-80,21 (28,218)	-82,31 (29,048)
Italy	-99,37 (92,388)	-82,66 (55,62)	2,83 (48,002)	42,71 (46,217)	48,55 (50,023)	55,42 (47,321)	41,71 (43,839)	25,82 (43,155)
Netherlands	116,33 (65,624)	108,15 (68,425)	86,22 (62,928)	75,83 (54,661)	60,34 (45,99)	45,23 (39,139)	36,27 (33,08)	27 (27,829)
Norway	-69,29 (65,281)	-51,8 (51,613)	-59,95 (48,386)	-67,63 (47,606)	-63,73 (44,407)	-59,02 (42,597)	-54,83 (40,704)	-56,69 (39,877)
Portugal	-70,31 (64,893)	-64,31 (58,719)	-87,93 (50,367)	-47,85 (54,936)	-31,57 (49,685)	-31,98 (47,412)	-13,33 (41,951)	-18,31 (35,799)
Spain	27,5 (33,915)	27,23 (33,467)	24,71 (30,147)	17,74 (26,91)	10,36 (25,488)	8,26 (24,835)	13,66 (24,011)	15,59 (22,587)
Sweden	227,35 (63,43)	218,9 (69,422)	195,94 (71,463)	169,29 (71,711)	136,87 (68,623)	102,77 (64,774)	74,72 (60,099)	54,07 (58,1)
Switzerland	-14,94 (90,691)	-8,7 (62,398)	65,2 (51,15)	72,24 (41,234)	57,45 (36,108)	76,5 (30,973)	66,7 (30,025)	68,83 (32,886)
United Kingdom	39,27 (27,685)	48,68 (26,42)	50,23 (26,638)	50,33 (27,116)	45,63 (26,41)	38,92 (24,946)	32,49 (23,42)	28,83 (21,864)

Table B.2 - Estimated Slope Coefficient (α_1) of the YS model for different time horizons – Whole period

Dependent variable: Real Gross Domestic Product *

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	49,7 (18,226)	47,59 (17,516)	41,92 (16,079)	35,75 (14,826)	31,72 (13,786)	29,96 (12,709)	28,57 (11,638)	28,27 (10,494)
France	-41,07 (18,708)	-42,94 (18,298)	-42,81 (18,164)	-42,72 (17,773)	-41,07 (17,571)	-38,85 (16,936)	-36,4 (16,211)	-34,12 (15,275)
Germany	64,65 (27,949)	62,67 (26,175)	58,47 (24,843)	55,36 (23,432)	53,41 (21,858)	49,97 (19,399)	47,47 (16,985)	44,61 (15,338)
Ireland	-21,41 (25,094)	-23,42 (23,991)	-26,3 (23,186)	-29,27 (21,798)	-32,31 (20,585)	-32,78 (19,904)	-31,87 (19,869)	-28,65 (20,374)
Italy	-20,91 (39,773)	-14,01 (27,411)	1,25 (23,848)	7,09 (23,037)	9,15 (22,065)	9,86 (20,721)	5,91 (20,478)	12,83 (16,39)
Netherlands	32,93 (26,784)	38,11 (28,952)	41,47 (29,184)	44,38 (28,479)	45,95 (27,629)	44,53 (27,106)	42,5 (26,713)	38,81 (26,355)
Norway	56,99 (23,981)	49,77 (23,878)	38,1 (25,202)	27,98 (26,93)	28,12 (24,238)	28,55 (22,665)	28,81 (20,695)	26,58 (20,837)
Portugal	-5,47 (44,412)	-40,03 (40,52)	-43,15 (35,87)	-43,56 (38,179)	-49,61 (37,514)	-44,73 (47,086)	-35,2 (37,721)	-29,6 (33,564)
Spain	3,16 (10,67)	3,62 (11,037)	4,91 (11,399)	5,58 (11,395)	5,25 (11,369)	4,74 (11,575)	4,18 (11,728)	3,94 (12,024)
Sweden	142,22 (22,205)	143,1 (21,276)	137,44 (22,986)	125,8 (23,968)	112,15 (23,018)	100,1 (23,507)	88,85 (24,389)	79,8 (23,567)
Switzerland	-14,72 (49,098)	-17,83 (41,236)	-27,7 (31,756)	-11,82 (30,201)	-17,28 (25,512)	-14,42 (26,14)	-16,93 (23,38)	-12,02 (21,339)
United Kingdom	26,34 (19,964)	31,76 (20,923)	33,56 (21,768)	34,92 (22,271)	35,06 (22,306)	33,58 (21,86)	32,49 (21,208)	31,41 (20,424)

Table B.3- Estimated Slope Coefficient (α_1) of the YS model for different time horizons – Prior to 2008

Dependent variable: Industrial Production *

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	163,28 (43,633)	148,11 (37,937)	144,11 (31,947)	125,59 (25,144)	110,69 (22,191)	97,55 (20,903)	90,72 (19,445)	87,5 (18,722)
France	-126,23 (47,553)	-103,13 (40,701)	-89,5 (38,549)	-78,05 (38,226)	-65,37 (38,993)	-51,65 (37,093)	-42,71 (35,022)	-38,45 (32,616)
Germany	-3,93 (107,37)	56,41 (100,694)	26,08 (96,118)	35,23 (97,251)	35,23 (87,681)	36,27 (87,142)	55,82 (81,185)	66,28 (76,089)
Ireland	99,31 (57,727)	65,54 (64,086)	34,65 (64,66)	35,9 (58,707)	28,63 (52,088)	10,61 (49,124)	-3,82 (48,685)	-14,11 (50,215)
Italy	28,16 (52,543)	19,03 (46,399)	11,13 (38,045)	-1,27 (35,173)	-17,8 (32,623)	-27,29 (30,382)	-34,37 (29,878)	-37,91 (31,031)
Netherlands	371,59 (146,748)	343,8 (93,928)	171,7 (104,164)	149,94 (81,629)	140,99 (70,442)	95,23 (62,275)	89,23 (61,633)	57,45 (48,973)
Norway	-5,7 (214,718)	96,52 (124,071)	86,58 (89,162)	29,62 (76,864)	10,26 (59,474)	-1,15 (56,156)	27,65 (54,957)	18,25 (48,318)
Portugal	118,86 (54,345)	124,8 (43,814)	134,72 (36,763)	149,26 (28,951)	144,23 (26,505)	137,67 (28,247)	128,96 (29,335)	116,87 (32,009)
Spain	49,18 (53,506)	38,45 (50,957)	31,49 (43,339)	19,45 (37,766)	7,27 (35,554)	2,86 (33,393)	8,92 (31,409)	14,42 (29,325)
Sweden	180,92 (82,734)	181,4 (68,26)	198,91 (59,74)	181,8 (45,302)	157,49 (34,517)	129,38 (28,046)	109,04 (33,761)	117,63 (38,526)
Switzerland	21,05 (97,835)	-34,42 (59,656)	61,35 (47,163)	68,36 (36,971)	49,32 (35,98)	58,79 (29,411)	56,48 (29,419)	56,3 (32,468)
United Kingdom	-70,44 (91,425)	-23,03 (52,633)	-18,17 (46,3)	13,12 (39,773)	16,97 (38,456)	16,83 (36,211)	12,49 (36,219)	22,7 (34,566)

Table B.4- Estimated Slope Coefficient (α_1) of the YS model for different time horizons – Prior to 2008

Dependent variable: Real Gross Domestic Product *

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	64,94 (17,623)	59,69 (15,683)	51,88 (13,636)	44,06 (12,048)	38,51 (10,82)	36,08 (9,931)	34,3 (9,088)	33,27 (7,965)
France	-51,48 (18,277)	-48,05 (15,957)	-44,79 (15,147)	-42,53 (14,259)	-39,21 (13,93)	-36,17 (13,351)	-33,87 (12,86)	-32,02 (12,086)
Germany	16,48 (55,806)	37,3 (49,717)	21,6 (48,294)	11,23 (45,694)	3,6 (42,697)	-13,36 (47,819)	-4,51 (46,812)	-1,74 (45,918)
Ireland	56,88 (28,299)	54,53 (29,271)	49,83 (30,128)	41,45 (29,058)	33,08 (28,404)	26,02 (28,558)	21,92 (29,192)	19,58 (29,054)
Italy	-2,74 (22,426)	-4,4 (20,818)	-6,79 (19,276)	-10,84 (18,332)	-17,59 (16,751)	-22,25 (15,432)	-24,89 (14,468)	-26,84 (14,315)
Netherlands	5,89 (68,957)	-28,44 (56,69)	-30,29 (50,321)	-24,27 (48,102)	-10,56 (46,854)	-17,37 (47,598)	-0,47 (47,226)	2,38 (44,431)
Norway	97,21 (52,025)	117,63 (34,366)	100,69 (27,973)	34,04 (25,777)	24,51 (26,221)	21,18 (21,125)	29,15 (22,124)	26,92 (18,743)
Portugal	64,57 (31,169)	60,99 (24,669)	68,73 (24,136)	73,75 (20,594)	74,71 (18,777)	75,67 (15,929)	71,08 (17,51)	66,46 (15,882)
Spain	5,12 (15,703)	2,26 (15,929)	3,26 (15,959)	3,85 (15,386)	3,57 (14,478)	2,88 (14,179)	2,58 (14,226)	2,79 (14,457)
Sweden	18 (50,337)	33,55 (29,203)	67,48 (31,524)	62,62 (29)	47,69 (22,63)	45,42 (19,005)	42,43 (16,881)	41,12 (17,059)
Switzerland	6,8 (41,405)	-11,09 (35,995)	-22,15 (26,726)	-8,41 (25,245)	-16,41 (21,796)	-16,31 (22,59)	-16,79 (20,183)	-10,33 (19,984)
United Kingdom	-40,55 (40,527)	-21,71 (32,979)	-13,22 (30,048)	0,9 (30,358)	4,2 (26,433)	-3,47 (23,122)	2,98 (23,343)	12,04 (23,99)

* Standard errors are represented in parenthesis

Table B.5 - General assessment of in-sample forecasting of the YS model - Average of estimated R-squared of tables IS.1, IS.2, IS.7 and IS.8

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	10,1%	15,7%	18,8%	19,0%	19,2%	18,6%	19,0%	20,0%
France	8,6%	11,4%	12,3%	13,0%	12,5%	11,3%	10,4%	10,1%
Germany	4,9%	7,4%	9,3%	11,3%	13,5%	14,4%	14,8%	14,5%
Ireland	1,2%	2,4%	3,0%	3,3%	3,7%	3,7%	3,7%	3,7%
Italy	0,3%	0,3%	0,1%	0,3%	0,9%	1,7%	2,5%	3,4%
Netherlands	3,9%	6,8%	3,4%	4,0%	4,6%	4,0%	3,9%	3,2%
Norway	1,1%	2,4%	2,5%	2,1%	2,5%	2,6%	3,0%	3,0%
Portugal	2,5%	5,5%	9,1%	12,0%	13,2%	14,0%	13,3%	12,3%
Spain	0,3%	0,4%	0,6%	0,4%	0,2%	0,1%	0,3%	0,4%
Sweden	9,5%	14,4%	17,4%	17,2%	15,5%	13,1%	11,1%	10,8%
Switzerland	0,1%	0,1%	0,4%	0,4%	0,4%	0,7%	0,7%	0,7%
United Kingdom	1,3%	2,0%	2,6%	3,6%	5,6%	5,7%	3,3%	3,2%

Legend:

Best performance

Worst performance

Appendix C – In-Sample analysis: Benchmarks

Appendix C.1- AR model

Table C.1.1- MAD of the AR model: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,68	3,34	2,52	2,02	1,55	1,38	1,17	1,07	**2,34**
France	3,82	2,20	1,60	1,32	1,11	0,96	0,82	0,69	**1,57**
Germany	5,04	3,07	2,35	1,91	1,58	1,32	1,16	1,04	**2,19**
Ireland	11,20	6,54	4,63	3,68	2,75	2,18	2,12	1,91	**4,37**
Italy	4,89	2,89	2,12	1,89	1,54	1,35	1,11	1,00	**2,10**
Netherlands	6,86	4,24	2,59	2,17	1,81	1,50	1,33	1,08	**2,70**
Norway	8,86	5,00	3,58	2,90	2,19	2,08	1,59	1,49	**3,46**
Portugal	6,12	3,64	2,52	2,07	1,70	1,42	1,23	1,00	**2,46**
Spain	1,23	1,00	7,20	4,35	3,00	2,64	1,91	1,76	**2,89**
Sweden	1,39	1,36	6,19	3,75	2,77	2,18	1,74	1,57	**2,62**
Switzerland	4,47	2,58	2,03	1,68	1,39	1,21	1,01	0,92	**1,91**
United Kingdom	3,37	2,05	1,52	1,22	1,00	0,83	0,71	0,67	**1,42**

Table C.1.2- MAD of the AR model: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,75	1,10	0,81	0,69	0,53	0,44	0,40	0,33	**0,76**
France	1,24	0,76	0,59	0,47	0,40	0,35	0,31	0,26	**0,55**
Germany	2,75	1,66	1,14	0,82	0,75	0,67	0,56	0,50	**1,11**
Ireland	4,44	2,13	1,80	1,43	1,10	1,06	0,80	0,79	**1,69**
Italy	1,93	1,17	0,82	0,69	0,58	0,48	0,43	0,37	**0,81**
Netherlands	2,50	1,40	1,05	0,82	0,60	0,56	0,50	0,45	**0,98**
Norway	3,87	2,17	1,66	1,24	0,99	0,93	0,68	0,74	**1,54**
Portugal	3,35	1,95	1,30	0,99	0,85	0,79	0,59	0,57	**1,30**
Spain	0,59	0,57	1,65	1,05	0,79	0,66	0,53	0,45	**0,79**
Sweden	0,41	0,36	3,20	1,84	1,38	1,13	0,86	0,76	**1,24**
Switzerland	2,28	1,07	0,76	0,70	0,51	0,49	0,39	0,38	**0,82**
United Kingdom	1,83	1,12	0,85	0,69	0,57	0,47	0,42	0,39	**0,79**

Table C.1.3 - MAD of the AR model: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,65	3,29	2,47	1,95	1,47	1,31	1,11	1,02	**2,28**
France	3,83	2,13	1,57	1,24	1,06	0,92	0,76	0,65	**1,52**
Germany	5,03	2,99	2,23	1,80	1,49	1,23	1,08	0,98	**2,11**
Ireland	11,06	6,23	4,53	3,72	2,72	2,24	2,16	1,87	**4,32**
Italy	5,11	2,92	2,04	1,84	1,48	1,29	1,04	0,93	**2,08**
Netherlands	6,66	4,13	2,57	2,11	1,78	1,48	1,27	1,06	**2,63**
Norway	8,20	4,67	3,53	2,67	2,13	1,93	1,51	1,46	**3,26**
Portugal	6,04	3,52	2,50	1,98	1,64	1,39	1,20	0,96	**2,40**
Spain	1,20	0,96	7,46	4,46	2,99	2,71	1,94	1,78	**2,94**
Sweden	6,21	3,71	2,69	2,09	1,66	1,53	1,31	1,18	**2,55**
Switzerland	4,52	2,57	2,03	1,65	1,38	1,20	0,98	0,91	**1,91**
United Kingdom	3,40	2,09	1,51	1,20	0,98	0,82	0,70	0,67	**1,42**

Table C.1.4 – MAD of the AR model: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,83	1,13	0,85	0,70	0,53	0,45	0,39	0,32	**0,77**
France	1,24	0,76	0,59	0,46	0,39	0,34	0,30	0,26	**0,54**
Germany	2,90	1,69	1,17	0,81	0,76	0,67	0,56	0,49	**1,13**
Ireland	4,51	2,16	1,82	1,45	1,13	1,07	0,81	0,78	**1,71**
Italy	1,98	1,18	0,81	0,68	0,56	0,46	0,41	0,35	**0,80**
Netherlands	1,66	1,23	0,94	0,92	0,64	0,79	2,71	1,60	**1,31**
Norway	1,15	0,98	0,77	0,71	0,65	0,55	2,09	1,11	**1,00**
Portugal	3,39	1,95	1,30	0,98	0,84	0,79	0,57	0,56	**1,30**
Spain	0,57	0,56	1,72	1,07	0,81	0,66	0,52	0,44	**0,79**
Sweden	3,24	1,82	1,36	1,10	0,82	0,75	0,65	0,63	**1,30**
Switzerland	2,21	1,12	0,78	0,72	0,51	0,49	0,39	0,39	**0,83**
United Kingdom	1,87	1,14	0,85	0,71	0,58	0,47	0,43	0,39	**0,81**

Appendix C.2- RW model

Table C.2.1- MAD of the RW model: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	7,68	3,85	2,85	2,18	1,64	1,46	1,22	1,13	**2,75**
France	4,75	2,38	1,69	1,38	1,15	1,00	0,85	0,72	**1,74**
Germany	6,30	3,38	2,47	2,04	1,65	1,38	1,20	1,08	**2,44**
Ireland	16,07	7,27	4,97	3,89	2,77	2,23	2,16	2,00	**5,17**
Italy	5,85	3,26	2,26	2,00	1,60	1,41	1,15	1,01	**2,32**
Netherlands	10,35	4,97	3,01	2,50	2,00	1,67	1,48	1,13	**3,39**
Norway	13,88	6,13	4,16	3,22	2,25	2,16	1,68	1,51	**4,38**
Portugal	8,51	4,18	2,65	2,17	1,74	1,45	1,28	1,04	**2,88**
Spain	1,28	1,04	10,08	4,98	3,32	2,78	2,02	1,82	**3,41**
Sweden	1,43	1,41	8,31	4,16	2,87	2,31	1,80	1,61	**2,99**
Switzerland	5,55	2,72	2,14	1,73	1,43	1,23	1,02	0,93	**2,09**
United Kingdom	4,06	2,28	1,67	1,31	1,02	0,87	0,74	0,69	**1,58**

Table C.2.2 - MAD of the RW model: In-sample estimation for several quarters ahead - Whole Period
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	2,09	1,19	0,86	0,72	0,55	0,47	0,41	0,33	**0,83**
France	1,45	0,79	0,61	0,49	0,41	0,35	0,31	0,27	**0,59**
Germany	3,61	1,87	1,26	0,87	0,81	0,70	0,59	0,52	**1,28**
Ireland	5,08	2,22	1,87	1,47	1,14	1,07	0,80	0,80	**1,81**
Italy	2,24	1,26	0,84	0,72	0,59	0,49	0,44	0,37	**0,87**
Netherlands	3,24	1,45	1,13	0,83	0,62	0,58	0,49	0,45	**1,10**
Norway	6,16	2,67	1,93	1,38	1,03	1,00	0,72	0,76	**1,96**
Portugal	4,23	2,10	1,35	1,02	0,86	0,80	0,59	0,57	**1,44**
Spain	0,59	0,57	1,97	1,11	0,81	0,70	0,52	0,45	**0,84**
Sweden	0,40	0,36	4,62	2,08	1,48	1,16	0,89	0,80	**1,47**
Switzerland	2,59	1,11	0,78	0,73	0,51	0,49	0,40	0,38	**0,87**
United Kingdom	2,11	1,21	0,91	0,75	0,60	0,48	0,44	0,40	**0,86**

Table C.2.3- MAD of the RW model: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	2,15	1,21	0,90	0,74	0,56	0,48	0,41	0,32	**0,85**
France	1,39	0,78	0,61	0,49	0,40	0,35	0,30	0,26	**0,57**
Germany	12,92	5,66	4,02	2,96	2,21	1,99	1,59	1,49	**4,10**
Ireland	4,95	2,27	1,84	1,48	1,15	1,07	0,81	0,78	**1,79**
Italy	2,25	1,26	0,83	0,72	0,58	0,47	0,42	0,35	**0,86**
Netherlands	8,21	4,02	2,65	2,07	1,68	1,41	1,24	1,00	**2,78**
Norway	10,41	5,02	3,28	2,85	2,04	1,84	1,46	1,44	**3,54**
Portugal	4,32	2,13	1,35	1,03	0,86	0,80	0,58	0,57	**1,46**
Spain	0,58	0,57	1,97	1,12	0,81	0,69	0,52	0,43	**0,84**
Sweden	8,42	4,00	2,72	2,20	1,74	1,59	1,34	1,24	**2,91**
Switzerland	5,48	2,66	2,13	1,70	1,42	1,22	0,98	0,92	**2,06**
United Kingdom	4,01	2,28	1,63	1,28	0,99	0,85	0,73	0,68	**1,55**

Table C.2.4 - MAD of the RW model: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	7,75	3,81	2,81	2,12	1,57	1,39	1,15	1,06	**2,71**
France	4,46	2,23	1,63	1,29	1,09	0,95	0,79	0,68	**1,64**
Germany	7,75	3,81	2,81	2,12	1,57	1,39	1,15	1,06	**2,71**
Ireland	16,16	7,10	4,98	3,94	2,73	2,32	2,22	1,98	**5,18**
Italy	5,90	3,16	2,16	1,91	1,52	1,32	1,07	0,94	**2,25**
Netherlands	4,46	2,23	1,63	1,29	1,09	0,95	0,79	0,68	**1,64**
Norway	5,80	3,19	2,32	1,91	1,55	1,28	1,11	1,00	**2,27**
Portugal	8,21	4,02	2,65	2,07	1,68	1,41	1,24	1,00	**2,78**
Spain	1,24	1,00	10,41	5,02	3,28	2,85	2,04	1,84	**3,46**
Sweden	16,16	7,10	4,98	3,94	2,73	2,32	2,22	1,98	**5,18**
Switzerland	5,90	3,16	2,16	1,91	1,52	1,32	1,07	0,94	**2,25**
United Kingdom	10,01	4,77	2,92	2,39	1,95	1,64	1,41	1,11	**3,27**

Appendix C.3- AR + YS model

Table C.3.1- MAD AR+YS model: In-sample estimation for several quarters ahead – Whole Period
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,38	3,24	2,46	2,00	1,50	1,38	1,14	1,07	**2,27**
France	3,62	2,18	1,60	1,33	1,06	0,97	0,83	0,69	**1,54**
Germany	4,95	3,01	2,31	1,94	1,55	1,25	1,11	1,04	**2,15**
Ireland	12,02	6,85	4,92	3,81	2,91	2,27	2,27	2,03	**4,63**
Italy	4,81	2,84	2,14	1,90	1,56	1,37	1,12	1,01	**2,09**
Netherlands	6,26	3,87	2,50	1,97	1,68	1,38	1,23	1,06	**2,49**
Norway	8,92	5,04	3,65	2,93	2,08	1,94	1,50	1,39	**3,43**
Portugal	5,76	3,50	2,39	2,02	1,69	1,35	1,20	1,03	**2,37**
Spain	1,19	1,02	7,19	4,32	2,97	2,63	1,92	1,75	**2,88**
Sweden	1,39	1,35	5,73	3,56	2,74	2,12	1,72	1,49	**2,51**
Switzerland	4,51	2,58	2,00	1,68	1,39	1,22	1,01	0,93	**1,92**
United Kingdom	3,14	1,87	1,41	1,07	0,87	0,77	0,66	0,62	**1,30**

Table C.3.2- MAD AR+YS model MAD: In-sample estimation for several quarters ahead – Whole Period
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,74	1,07	0,79	0,69	0,53	0,45	0,40	0,32	**0,75**
France	1,22	0,76	0,58	0,46	0,39	0,34	0,30	0,26	**0,54**
Germany	2,65	1,63	1,13	0,81	0,76	0,67	0,56	0,50	**1,09**
Ireland	5,47	2,57	2,13	1,65	1,23	1,21	0,89	0,92	**2,01**
Italy	0,93	1,94	1,17	0,81	0,69	0,58	0,49	0,43	**0,88**
Netherlands	1,81	1,15	0,84	0,66	0,50	0,44	0,41	0,37	**0,77**
Norway	3,61	2,07	1,62	1,27	0,94	0,93	0,66	0,75	**1,48**
Portugal	0,36	3,29	1,88	1,26	0,94	0,82	0,77	0,54	**1,23**
Spain	0,55	0,55	1,64	1,05	0,80	0,66	0,53	0,45	**0,78**
Sweden	0,41	0,36	2,71	1,62	1,16	1,01	0,82	0,71	**1,10**
Switzerland	0,55	2,27	1,08	0,75	0,69	0,51	0,48	0,40	**0,84**
United Kingdom	1,71	1,05	0,88	0,68	0,55	0,45	0,42	0,37	**0,76**

Table C.3.3- MAD of the AR + YS models: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: IP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	5,35	3,18	2,40	1,91	1,43	1,29	1,09	1,01	**2,21**
France	3,71	2,12	1,56	1,25	1,03	0,93	0,76	0,65	**1,50**
Germany	4,93	2,91	2,19	1,80	1,48	1,18	1,05	0,98	**2,07**
Ireland	11,63	6,47	4,94	3,90	2,89	2,39	2,35	2,00	**4,57**
Italy	5,11	2,89	2,05	1,84	1,48	1,29	1,03	0,91	**2,08**
Netherlands	5,85	3,70	2,43	1,87	1,64	1,33	1,13	1,05	**2,38**
Norway	8,19	4,67	3,59	2,68	2,01	1,74	1,41	1,35	**3,20**
Portugal	5,68	3,30	2,42	1,86	1,61	1,30	1,15	0,97	**2,29**
Spain	1,15	0,97	7,35	4,42	2,97	2,71	1,94	1,77	**2,91**
Sweden	5,83	3,58	2,68	2,02	1,63	1,46	1,28	1,12	**2,45**
Switzerland	4,44	2,54	1,98	1,67	1,38	1,21	0,98	0,91	**1,89**
United Kingdom	3,14	1,88	1,40	1,03	0,83	0,75	0,64	0,60	**1,28**

Table C.3.4- MAD of the AR+YS models: In-sample estimation for several quarters ahead – Prior to 2008
Dependent variable: Real GDP

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q	Average
Belgium	1,79	1,09	0,82	0,70	0,53	0,45	0,39	0,32	**0,76**
France	1,22	0,76	0,58	0,46	0,39	0,34	0,30	0,26	**0,54**
Germany	2,82	1,68	1,16	0,80	0,77	0,67	0,56	0,49	**1,12**
Ireland	5,33	2,67	2,22	1,72	1,29	1,24	0,92	0,93	**2,04**
Italy	1,98	1,18	0,81	0,68	0,57	0,46	0,41	0,35	**0,80**
Netherlands	1,77	1,08	0,80	0,63	0,49	0,42	0,37	0,36	**0,74**
Norway	3,50	2,04	1,66	1,23	0,94	0,92	0,64	0,79	**1,47**
Portugal	3,21	1,85	1,26	0,91	0,82	0,75	0,53	0,54	**1,23**
Spain	0,53	0,54	1,72	1,06	0,81	0,66	0,52	0,44	**0,78**
Sweden	2,71	1,60	1,15	0,98	0,77	0,71	0,65	0,55	**1,14**
Switzerland	2,09	1,11	0,78	0,71	0,51	0,49	0,39	0,38	**0,81**
United Kingdom	1,73	1,09	0,89	0,70	0,56	0,46	0,42	0,38	**0,78**

Appendix D – Out-of-sample Estimation

Table D.1- R-squared: Average of historical periods and dependent variables - Out-of-sample estimation

	1 - Q	2 - Q	3 - Q	4 - Q	5 - Q	6 - Q	7 - Q	8 - Q
Belgium	53,5%	51,2%	52,1%	53,7%	53,5%	54,8%	55,3%	57,1%
France	46,3%	48,5%	50,8%	52,7%	53,6%	54,6%	54,7%	55,1%
Germany	58,9%	55,2%	53,8%	54,5%	57,0%	57,8%	58,2%	59,1%
Ireland	20,5%	29,8%	33,2%	35,9%	39,8%	40,4%	41,2%	41,4%
Italy	45,2%	40,9%	40,6%	43,3%	44,0%	45,7%	46,8%	48,4%
Netherlands	67,4%	57,7%	51,0%	51,1%	52,9%	54,9%	55,4%	54,8%
Norway	65,3%	64,3%	60,2%	54,5%	53,3%	53,3%	54,1%	55,3%
Portugal	59,8%	57,1%	55,3%	55,3%	55,1%	55,4%	55,4%	56,4%
Spain	51,7%	48,1%	46,2%	45,6%	45,5%	46,2%	47,3%	48,2%
Sweden	64,7%	54,7%	57,7%	58,2%	59,6%	59,1%	59,6%	60,7%
Switzerland	56,1%	47,3%	47,5%	48,7%	49,2%	49,9%	50,1%	50,9%
United Kingdom	46,3%	46,2%	44,8%	44,0%	43,6%	44,1%	45,3%	46,5%

Legend:

Best performance

Worst performance