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THE YIELD CURVE AND THE PREDICTION ON THE BUSINESS CYCLE: A VAR ANALYSIS FOR THE EUROPEAN UNION

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ABSTRACT

The literature on the yield curve deals with the capacity to predict the future inflation and the future real growth from the term structure of the interest rates. The aim of the paper is to verify this predictive power of the yield curve for the European Union at 16 countries in the 1995-2008 years. With this regard we propose two VAR models. The former is derived from the standard approach, the later is an extended version considering explicitly the macroeconomic effects of the risk premium. We propose the estimates of the models and their out-of-sample forecasts through both the European Union GDP (Gross Domestic Product) quarterly series and the European Union IPI (Industrial Production Index) monthly series. We show that the our extended model performs better than the standard model and that the out-of-sample forecasts of the IPI monthly series are better than ones of the GDP quarterly series. Moreover the out-of-sample exercises seems us very useful because they show the crowding out arising from Lehman Brother's unexpected crash and the becoming next fine tuning process.

JEL classification: E43, E44, E47, E52

Keywords: yield curve, monetary policy, business cycle, risk premium, real growth

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THE YIELD CURVE AND THE PREDICTION ON THE BUSINESS CYCLE: A VAR ANALYSIS FOR THE EUROPEAN UNION

1. Introduction

The literature on the yield curve is very extensive and we are not able to discuss it exhaustively. The first papers investigating the relationship between the term structure of the interest rates and the inflation and output growth go back in the 1980's. These analysis found that the yield curve contains more information than stock returns in order to predict both the future inflation and the future growth of the real activities. On the one side, Harvey (Harvey 1988,1989) introduced the methodology showing as the term structure spread can accurately predict the GDP growth; on the other side, Mishkin (Mishkin 1990,1991) found that through the yield curve it's possible forecast the future inflation deriving the model from the Fisher condition. This results have been confirmed and extended by a lot of next papers. All of these studies dealing with the predictability of the yield curve are devoted to US countries and they confirm that the relationship between yield curve and inflation and output growth is highly significant. With regard to the forecast of the output they are explicitly suggesting in a period between the 4 and the 6 quarter ahead the "optimum" horizon and they find that an inverted yield curve can announce an impeding recession (amongst other Chu,1993; Estrella, Hardouvelis, 1991; Estrella, Mishkin,1997, 1998). Subsequent researchs investigate on whether the relationship between yield spread and future economic growth holds in countries other than the United States and a lot of papers find that the term structure predicts the output growth in several other countries, UK and Germany particularly (amongst other, Plosser, Rouwenhorst, 1994; Davis, Henry, 1994; Davis, Fagan, 1997; Funke, 1997; Ivanova et al., 2000). Finally, some studies are recently devoted in the EU Area and they confirm this relationship too (Moneta, 2003; Duarte et al., 2005).

The main questions arising from latest contributions concern the stability over time and across countries of the relationships (amongst other, Chauvet, Potter, 2002; Li et al., 2003). Therefore, although the relationship is statically stronger, there are some theoretical reasons indicating that she may be not stable. For instance, the theory suggest that the results may be different if the economy is responding to real (productivity) or monetary shocks, or if the central bank is targeting output or inflation. Estrella (2004) develops an analytical model in order to explain the empirical results. He suggests that the relationships are not structural, but are influenced by the monetary policy regime. However, the yield curve should have predictive power for inflation and output in most circumstances, for instance, when the monetary authority follows inflation targeting or when he follows the Taylor rule. In all the cases, "…*the information of the yield curve can be combined with other data to form the optimal predictors of output and inflation*." (Estrella, 2004; pag. 743). On the strictly empirical field, Estrella et al. (2003) use new econometric techniques to test the empirical relationships; they find that the models that predict real activity are more stable than those that predict inflation. Chauvet and Posset (2003) use different models in order to take into account some of the potential causes of the predictive instability of the yield curve; they also develop a new approach to the construction of forecasting of the recession probabilities. Ang et al. (2006) propose an dynamic model that characterizes completely the expectations on the output growth correcting the unconstrained and endogeneity problems arising from the previous studies.

In this paper we investigate on the yield curve and on its predictive power for the Euro Area (fixed at 16 countries) in the 1995-2008 years. In order to forecast the future growth of the real activities for the European Union we consider two VAR models. The former is the standard model where the yield spread is only used to forecast the output growth. Next, we present a more extensive model that is consistent with the macroeconomic and the financial theory; it is represented by six risk adjusted equations in order to include the impact of the market risk premium on the economic system. We use the VAR estimations to propose the out-of-sample forecasts both for Gross Domestic Product, GDP, (on quarterly frequency) and for Industrial Production Index, IPI, (on monthly frequency) annual growth rate of the European Union. We use also the monthly IPI series because they embed better the volatility of the changes of the interest rates. This last exercise seems us very useful because it allows us to show and to analyse the crowding out on the predictive power of the yield curve following the explosion of the bubble at the unexpected Leman Brother's crash and the expectations' next fine tuning. The data source is the statistical data of the European Central Bank.

The paper is organised as follows. Besides this introduction, in section 2 we discuss about the economics of the yield curve, while in the section 3 we investigate graphically about the basics of the yield curve of the European Union in the involved years. In the section 4 we present the methodology and the data of the empirical analysis. The section 5 is devoted to show the results of the VAR empirical analysis according to typical approach, while in the section 6 we illustrate the results of the VAR estimation and forecast according to our macroeconomic model. Finally there are some conclusive remarks and two appendixes.

2. The economics of the yield curve

It is well known that the yield curve is defined by the term structure of the interest rates on assets of different maturities. The slope of this curve is the differences between the long-term and the short-term interest rates and it gives the shape of the yield curve; this shape can differ over the time following the variations on the expectations on the inflation rate and over business cycle.

Fisher equation takes into account this dynamic because it analysis the link between the nominal yield on the different maturities r_t, the real interest rate $r_t^{\,r}$ and the expected inflation rate $\pi_t^{\,e}$:

$$[1] \qquad r_t = r_t^{\,r} + \pi_t^{\,e} \;\; [+ r_t^{\,r} \;\pi_t^{\,e}]$$

The real interest rate summarizes the real economic conditions while the expected inflation rate is represented by the inflation premium demanded by the investors in order to be ensured against the expected loss on the asset due to the future inflation. Therefore, the role of the time structure of expected inflation in the shape of the yield curve increases when the expected inflation rate is higher.

Fisher condition has to be adjusted if the uncertainty is introduced in the analysis. Given the hypothesis of risk-aversion of the investor, there is a risk premium devoted to compensate for the value losses. This market risk should be embedded in the nominal yield as a *risk premium* component: generally longer is the maturity of a bond, greater is the time of uncertainty and so higher is the market risk.

Therefore, considering that the term in brackets $[r_t^{\,r} \;\pi_t^{\,e}]$ is too small and not relevant for the analysis, a risk adjusted Fisher equation is

$$[2] \qquad r_t = r_t^{\,r} + \pi_t^{\,e} + mrp_t$$

where mrp_t is the market risk premium at time t. Naturally, in the short term there isn't the risk premium because there isn't uncertainty[1].

[1] Other kinds of risk premiums which should be embedded in this relationship are the liquidity risk premium and the default risk premium. Their inclusion would only complicate the analysis without changing the results; therefore in order to simplify our analysis they are excluded.

Since the slope of yield curve is the difference between the long-term (lr_t) and short-term interest rate (sr_t), we have

$$lr_t - sr_t = lr_t^{\,r} + l\pi_t^{\,e} + mrp_t - (sr_t^{\,r} + s\pi_t^{\,e})$$

and so

[4] $$lr_t - sr_t = (lr_t^{\,r} - sr_t^{\,r}) + (l\pi_t^{\,e} - s\pi_t^{\,e}]) + mrp_t.$$

that is, the difference between the nominal long-term and short-term rates is the expected change of real economic conditions ($lr_t^{\,r} - sr_t^{\,r}$) plus the expected change of inflation ($l\pi_t^{\,e} - s\pi_t^{\,e}$) plus the market risk premium (mrp_t).

The shape of the yield curve reflects the dynamic of these three components[2]. Given that short-term yields are usually lower than long-term yields mainly because long-term debt is less liquid and his price more volatile, a change in the shape of yield curve during the business cycle is often due to large movements in short-term rates without equal variations in long-term rates. Instead, a business expansion increases the short-term rate faster than long-term rate while during a recession it falls more rapidly.

Therefore, a “normal” shaped curve is evident when the economic activity is in a steady growth[3]. The inflation pressure is not high and there are not expectations on sudden changes in the business cycle. In this context the monetary policy is implemented in a neutral way in terms of targets as regard to the changes of the level prices or to the extension of the output gap[4].

[2] Generally, four kinds of the shape of the yield curve are considered: “normal curve”, “steep curve”, “flat curve” and “inverse curve”.

[3] Taylor (1998) arguments that for the U.S.A treasury bonds the yield curve takes this kind when the spread between the long-term and the short-term interest rate is the range of [1.50 , 2.50] basis points.

[4] For the most Central Banks fight inflation pressures using different tools is the main task, but for some of them (for example the Federal Reserve) there is also other important missions related to stimulate economic growth and to maintain the economy close to the full employment.

A “steep” shaped curve signals a stag of accommodative monetary policy in order to stimulate the economic activity. It is frequent at the trough of the business cycle and it anticipates of some months (6-12 months) a period of economic expansion. The spread is obviously greater than the upper limit of the one showed in the “normal shaped”[5].

The change from a positive to a negative economic growth can be anticipated by a *flattening* of yield curve that does not last for so too much time. A “flat” yield curve is usually near the peak of a business cycle and it is due generally to a sharp increase in short-term rates caused, for examples, by a strong demand for short term credit, by a credit crunch due a monetary tightening implemented against a large inflation pressure and by sudden movements in the expectations.

Finally, when the long-term are lower than short-term rates the yield curve is “inverse”. This can be evident when the Central Bank implements a huge and fast restrictive monetary policy to fight the inflationary shocks, as the ones due large and sudden increases of the oil prices. The business cycle suddenly changes when the slope of yield curve is negative and probably the recession is for-coming or just acting.

3. The yield curve for the European Monetary Union in 1994-2009 years.

We have determined on monthly basis the shape of the yield curve for the European Union (at 16 countries) in the years 1994-2009 through the difference between 10-year Euro area Government Benchmark Bond yield and Euribor 3-month interest rate[6]. This

[5] See Taylor (1998).

[6] For a detailed description of these data see next section .

curve with the line representing the European Central Bank (ECB) interest rate have been plotted in Fig.1[7].

As it can be noted, the shape of the yield curve is asymmetric as regard to the choice of monetary policy of the European Central Bank. When there is a monetary tightening the ECB interest rate increases and the slope of the curve goes down. Instead, the ECB interest rate decreases while the slope goes up when the monetary policy is accommodating.

Then, we have proposed a classification of the shape for the EU yield curve following the criteria by Taylor (Taylor, 1998)[8]. In Fig. 2 there is plotted a quarterly version of this curve for the period 1994:Q1-2009:Q2 with the legend of the different kinds of shape. This enables us to analyse the different stances of monetary policy and to forecast the turning points of the business cycle.

Then, if this line is compared with the GDP of the Euro Area (chain linked) at market prices, the relationship between the business cycle and the expectations embedded in the slope of the term structure of the interest rates can be graphically investigate[9]. In the Fig. 3 we have plotted for the quarters 1994:Q1-2009:Q2 the annual growth rate of GDP, the yield curve slope for the EMU and the ECB interest rate. We are able to confirm that the shape of the yield curve could be interpreted both as a predictor of the business cycle and as a tool to explain the effects on the real economy of the implementation of the monetary policy[10].

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[7] The ECB rate is the reference interest rate of the European Central Bank while she is implementing the monetary policy.

[8] We have considered that the yield curve is "normal" when the slope is limited in this range of basis points [1.50, 2.50]; it is a "steep curve" when the slope is higher than the upper limit of the "normal" one; it is an "inverse curve" when the slope is less than zero; it is a "flat curve" when the slope is greater than zero and lower than the inferior limit of the "normal curve".

[9] GDP is considered in annual growth rate on quarterly frequency.

[10] See Howard, 1989.

Fig. 1 – YIELD CURVE SLOPE AND EUROPEAN CENTRAL BANK INTEREST RATE (ECB) (Euro Area)

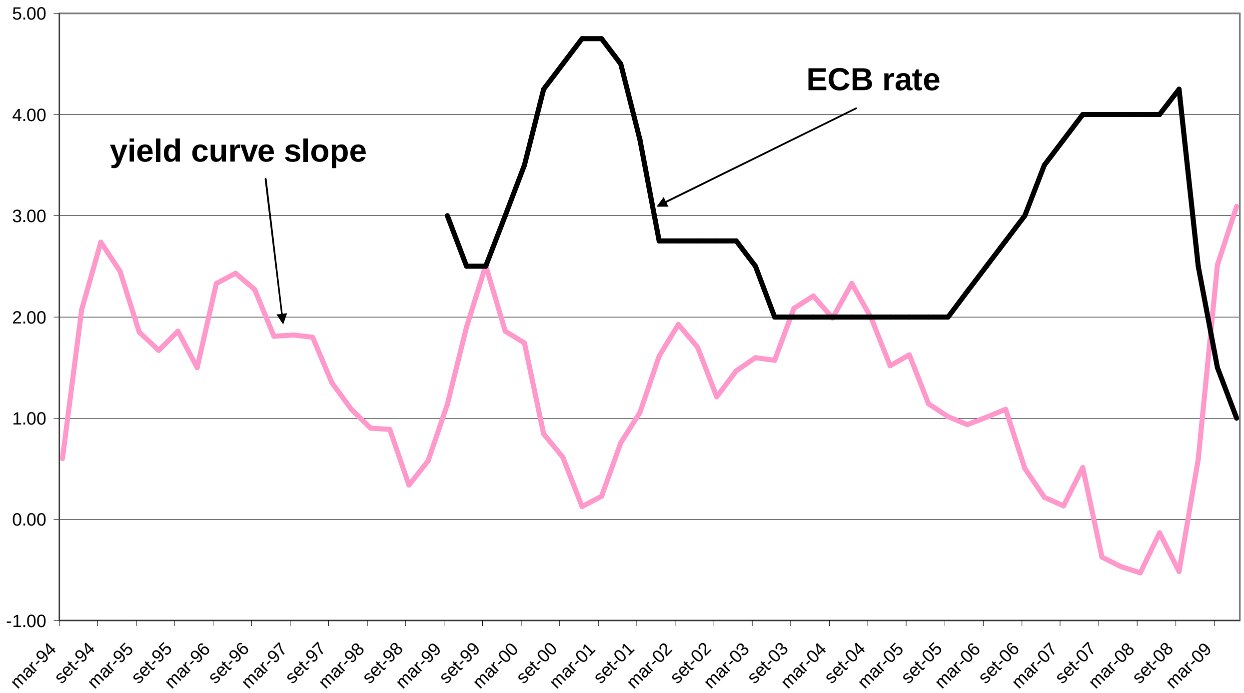


Fig. 2 - YIELD CURVE SLOPE RECLASSIFIED (Euro Area)

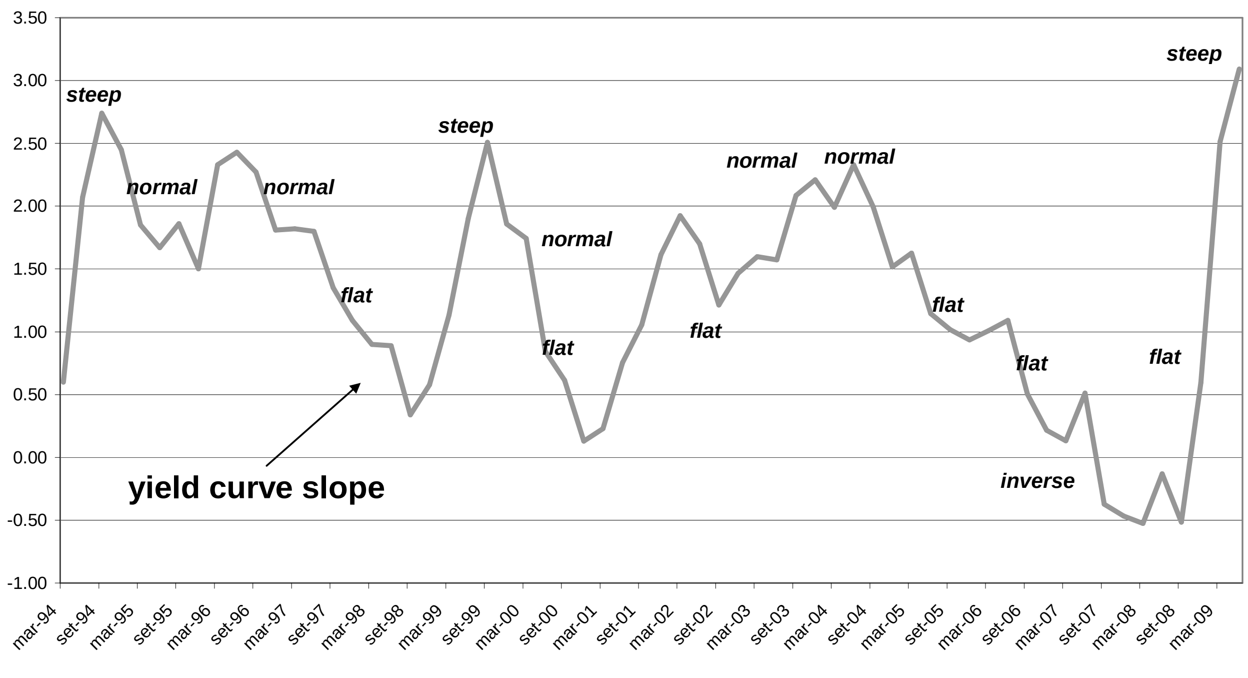
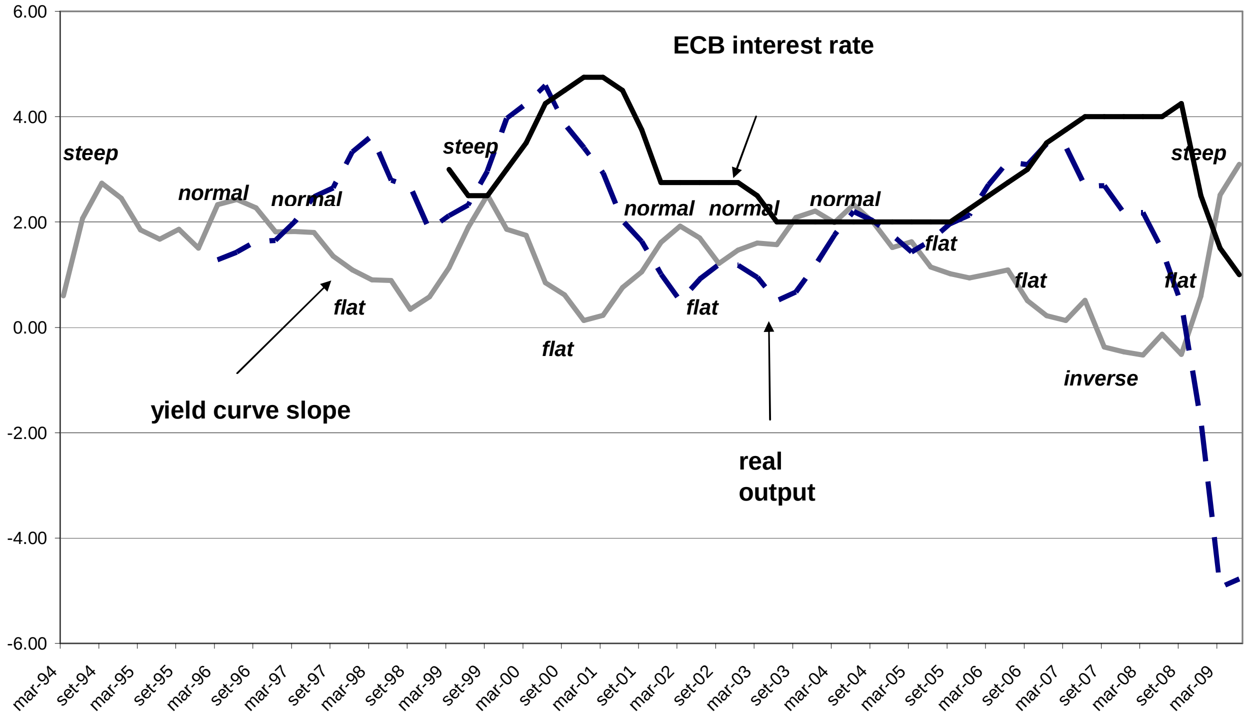


Fig. 3 - YIELD CURVE SLOPE AND BUSINESS CYCLE (Euro Area)



In the observed years a "steep curve" appears three times: on September 1994, on September 1999 and from March to June 2009. The steeping of the yield curve in the third quarter of 1999 points out an economic expansion achieving the peak nine months later: on June 2000 the annual growth rate for the Euro Area of GDP (chain linked) is equal to 4.6 %, the grater in the years from 1996 to 2009. The "steeped" section of the curve in the second quarter of 2009 is indicating a prediction of a large boost of the business cycle between the end of the previous year and the beginning of the actual one. The negative stage of the economy was been foresighted too much ahead of time by an inverted yield curve. In particular there was been a change in the direction of the yield curve with a flattening trend started from June 2005 up to September 2007 when the slope became negative: the "through" of the business cycle was on March 2009 after a big fall from September 2008. Another flattening trend of the yield curve, finished at the end of 2000, looks like to predict the fall on the business cycle culminated on March 2002 with an annual growth rate of the GDP chain linked equal to 0.5 %.

4. The methodology and the data for the empirical analysis

In order to analyse the relationship between the slope of the yield curve and the business cycle in the European Monetary Union, we present two Vector Auto-Regressive models. The former, VAR1, lies on the typical approach because it investigates only the information embedded in the interest rate spread to forecast the output growth. Through the latter, VAR2, we propose an alternative approach to estimate a more extensive model that is coherent with the macroeconomic theory and to forecast from it the output growth.

The large volatility of the short-term interest rates and the statistical assumptions suggest that both a quarterly frequency and a monthly frequency must be consider in order to be able to catch the underlying dynamic of the yield curve. Therefore, the estimate and the forecast concern two different output growth indices: the Gross Domestic Products (GDP) on quarterly basis and the Industrial Production Index (IPI) on monthly basis.

We estimate the two models with references to the Euro Area 16. The information source for the empirical analysis is the statistical data warehouse of the European Central Bank (http://sdw.ecb.europa.eu/). The variables taken into account to investigate the relationship between the slope of the yield curve and the business cycle are:

a. *EONIA* is the European Overnight Interest Rate for Euro Area on monthly basis from 1994:1 up to 2009:7;

b. ECB interest rate is the interest rate of European Central Bank for the main refinancing operations. It is the fixed rate tenders (fixed rate - date of changes) on monthly basis from 1999:1 up to 2000:5 and from 2008:10 up to 2009:7 and it is the variable rate tenders (minimum bid rate - date of changes) from 2000:6 up to 2009:7;

c. *EURIBOR3* is Euro Inter Bank Offered Rate 3-month on monthly basis from 1994:1 up to 2009:7;

d. *GBBY10* is 10-year Euro area Government Benchmark Bond Yield provided by ECB on monthly basis from 1970:1 up to 2009:7;

e. *GDP* is Euro area 16 (fixed composition) Gross Domestic Product at market price, Chain linked, ECU/euro, seasonally and partly working day adjusted, mixed method of adjustment, Annual growth rate on quarterly basis from 1996:Q1 up to 2009:Q2;

f. *IPI* is Euro area 16 (fixed composition) Industrial Production Index, Total Industry (excluding construction) - NACE Rev2, Eurostat, working day and seasonally adjusted, on monthly basis from 1990:1 up to 2009:8;

g. *HICIP* is Harmonised Index Consumer Prices - Overall index, annual rate of change, Eurostat, neither seasonally nor working day adjusted, Euro Area;

h. *DOW50* is Dow Jones Euro Stoxx 50 Price Index, historical close, average of observations through period, Euro Area, provided by ECB on monthly basis from 1970:1 up to 2009:8;

i. VOLATILITY is Eurex Generic 1st `RX` Future, implied bond volatility, end of period, provided by Bloomberg on monthly basis from 1993:6 up to 2009:8.

5. The empirical analysis in accordance with the typical model

The typical model is based on two endogenous variables: the slope of the yield curve and the output gap. The first variable ($SPREAD_t$) is determined as

$$\mathrm{SPREAD}_t = GBBY10_t - EURIBOR_t$$

while the second variable ($OUTPUT_{z,t}$ with z=GDP or IPI) as

$$\mathrm{OUTPUT}_{\mathrm{GDP},t} = \Delta\mathrm{REAL\_GDP}_t = \Delta_{t-4}\, GDP_t = \log(GDP_t) - \log(GDP_{t-4})$$

on quarterly basis, or

$$\mathrm{OUTPUT}_{\mathrm{IPI},t} = \Delta_{t-12}\,\mathrm{IPI}_t = \log(\mathrm{IPI}_t) - \log(\mathrm{IPI}_{t-12})$$

on monthly basis.

With reference to the European Union the previous two output indices present on quarterly frequency the same dynamic; this is showed clearly from the Fig. 4 where there is plotted the $\Delta REAL\_GDP_t$ and the $\Delta_{t-12}IPI_t$ quarterly series for the period 1996:Q1-2009-Q2 (correlation and statistics are in Appendix2, Tabb. A2.I and A2.II)[11]. Therefore in the first VAR model (VAR1) there are two endogenous variables ($i=1,2$) with only two lags ($j=1,2$)

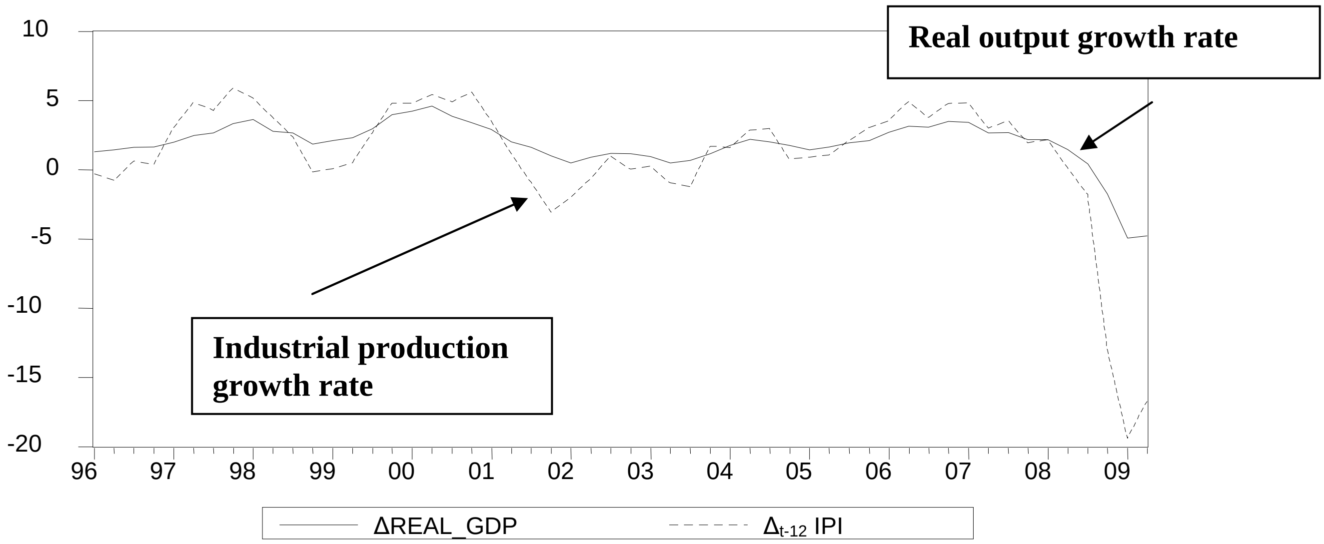
[11] The correlation coefficient between Δ REAL_GDP and $\Delta_{t-12}\, IPI_t$ quarterly series is 0.959723.

$$[5a] \quad SPREAD_{t} = \beta_{1,t}\ SPREAD_{t-j} + \delta_{1,t}\ OUTPUT_{t-j} + \alpha_{1} + \varepsilon_{1,t}$$

$$[5b] \quad OUTPUT_{i,t} = \beta_{2,t}\ SPREAD_{t-j} + \delta_{2,t}\ OUTPUT_{t-j} + \alpha_{2} + \varepsilon_{2t}$$

where $SPREAD_t$ is the difference between the long-term and short-term interest rate for t = 1,2, …,T; $OUTPUT_{i,t}$ is the output gap for t = 1,2, ……. T; α_1 , α_2 are the exogenous variables (intercepts); $\beta_{i,t}$ and $\delta_{i,t}$ are the coefficients of the two lagged endogenous variables; $\varepsilon_{i,t}$ are the stochastique innovations[12,13].

Fig. 4 - GDP VERSUS IPI ANNUAL GROWTH RATE (Euro Area)



[12] The assumptions about the innovations are that they may be contemporaneously correlated with each other but they are uncorrelated with their own lagged values and uncorrelated with all of the right-hand side variables respectively in the equations [5a]-[5b].

[13] If we impose that the long-run behaviour converge to their co-integrated relationships we take into account a Vector Error Correction (VEC) model, that is a restricted VAR model. In our analysis the VEC model have no trend and the cointegrating equations have an intercept. Considering just on lag we can write this simple model:

$$\Delta_{t-1}\ SPREAD_{t} = \gamma_{1}(OUTPUT_{t-1} - \mu + \beta_{1t}\ SPREAD_{t-1}) + \varepsilon_{1t}$$
$$\Delta_{t-1}\ OUTPUT_{t} = \gamma_{2}(SPREAD_{t-1} - \mu + \beta_{2t}\ OUTPUT_{t-1}) + \varepsilon_{2t}$$

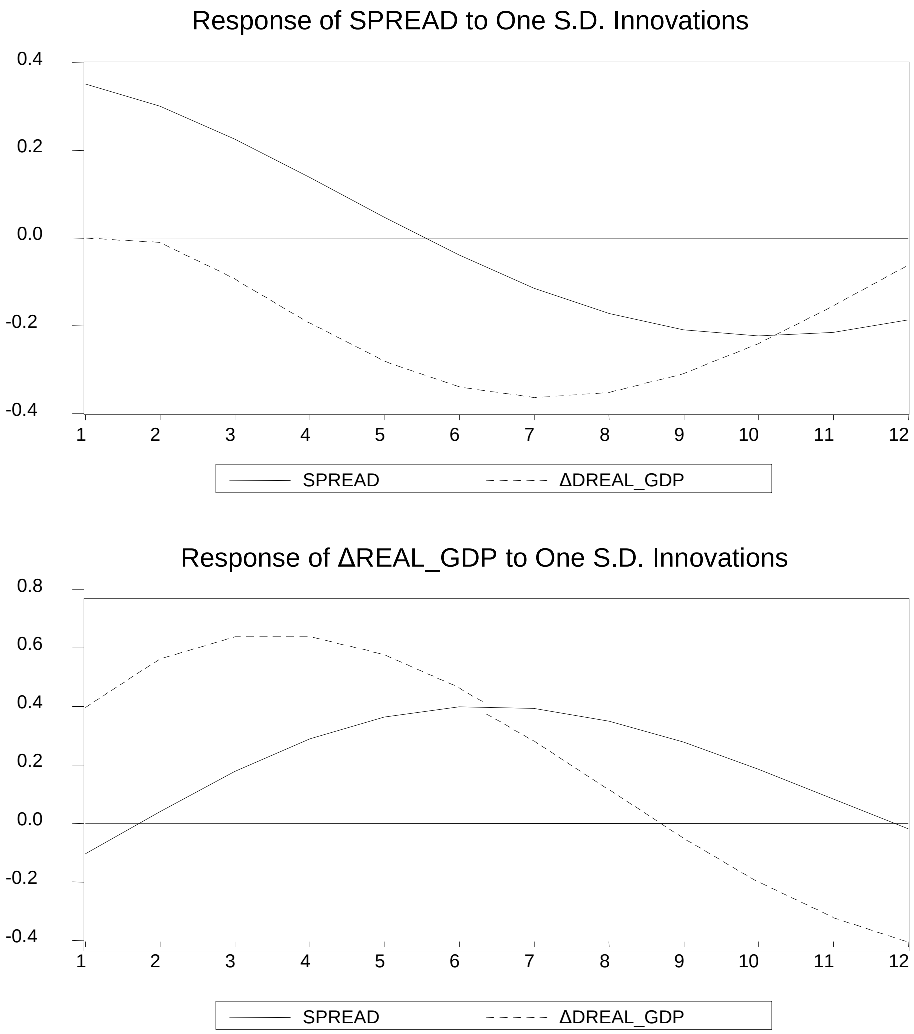
where:

- $\Delta_{t-1}\ SPREAD_{t}$: the first difference in logs of the spread between the long-term and short-term interest rate for t = 1,2, ……. T ,
- $\Delta_{t-1}\ OUTPUT_{t}$: the first difference in logs of the output gap for t = 1,2, ……. T ,
- γ_{1}, γ_{2} : the adjustment coefficients to the equilibrium.

We have estimated the VEC model too; the results of this analysis are convergent to ones of the VAR model (see Tabb. A2.I e A2.II of the Appendix2).

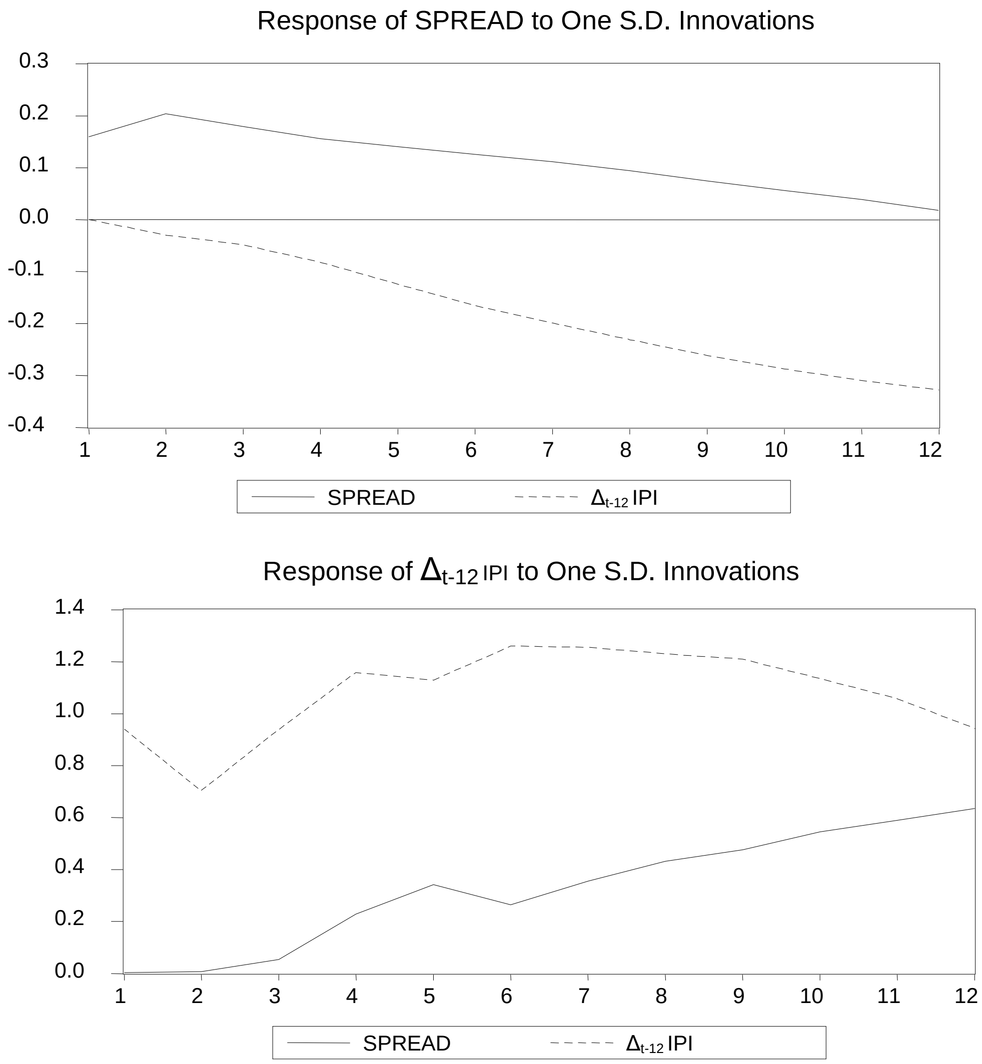
The estimation of VAR equations [5a]-[5b] with GDP quarterly series with two lags for the period 1996:Q1-2008:Q4 confirms that the information embedded in the slope of yield curve are useful to forecast the down turning of the business cycle. The impulse response function of $\Delta REAL\_GDP_t$ to innovations in $SPREAD_t$ points out that the changes in the slope of the yield curve are affecting on the business cycle with a persistence from the 3th up to the 8th quarter later (Fig. 5). The sum of β_{11} and β_{12} coefficients in equation [5b] is positive and equal to 0.308 (the sum of δ_{11} and δ_{12} coefficients is 1.030) confirming the theoretical predictions; their t-students statistics are rejecting the null hypothesis for each parameter ($H_0: \beta_{11} = \beta_{12} = \delta_{11} = \delta_{12} = 0$) (see Appendix1, Tab. A1.III).

Fig. 5 - IMPULSE RESPONSE FUNCTIONS FOR GDP IN VAR1 MODEL (Euro Area).



The VAR estimations in the model with the $\Delta_{t-12}IPI_t$ monthly series with six lags confirm the results obtained on the quarterly ones (see Appendix1 - Table A1.IV)[14]. The impulse response functions of this model are plotted in Fig. 6.

Fig. 6 - IMPULSE RESPONSE FUNCTIONS FOR IPI IN VAR1 MODEL (Euro Area).

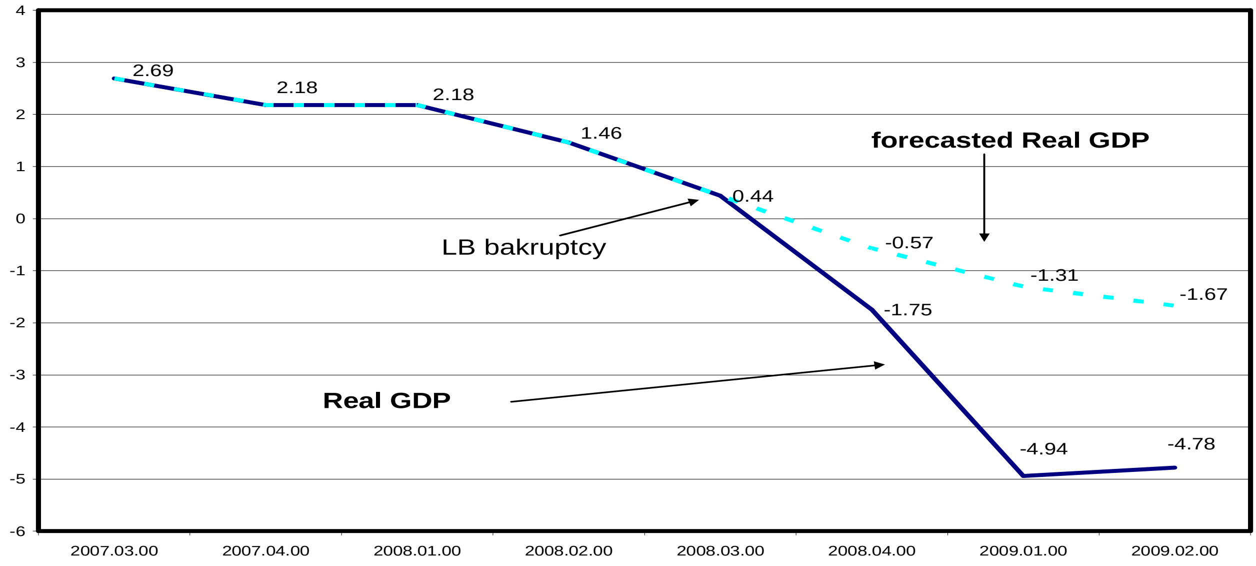


Then, we provide an exercise of the out-of-sample forecast for quarterly ΔREAL_GDP$_t$ series and for monthly $\Delta_{t-12}IPI_t$ series according to the estimated coefficients of equations [5a]-[5b] of the VAR1 model; the forecast method is dynamic. Both the forecasts are plotted in the Fig. 7. In the upper side of figure (7.1) there is the forecast of

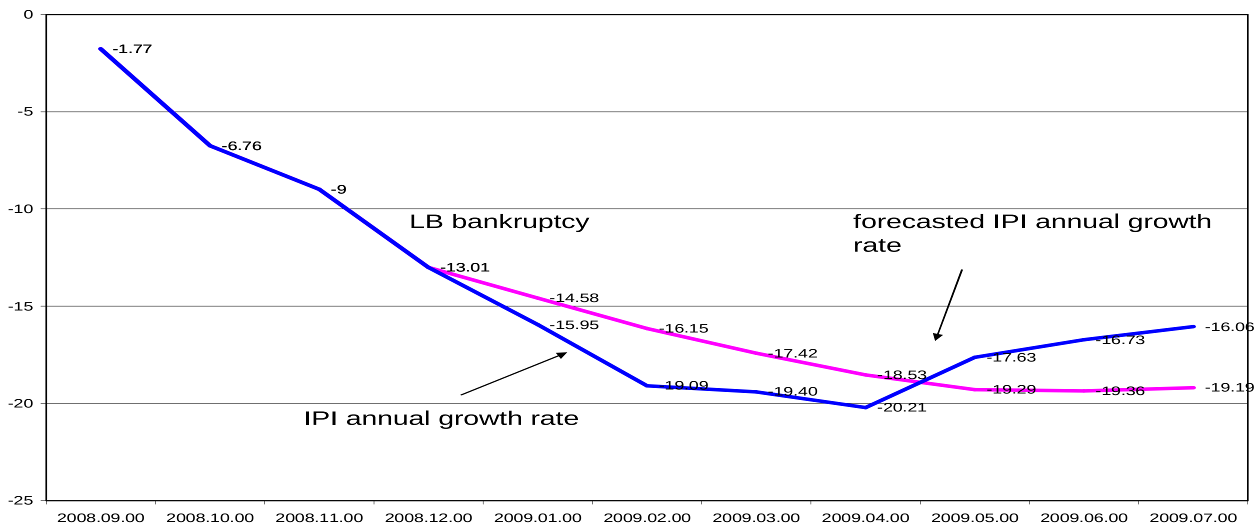
[14] However the standard errors of each coefficient of the equations [5a]-[5] on monthly series are larger than the quarterly estimated ones.

Fig. 7 - OUT-OF-SAMPLE FORECAST ACCORDING TO VAR1 MODEL

7.1 – QUARTERLY GDP SERIES



7.2 – MONTHLY IPI SERIES



ΔREAL_GDP$_t$ series for the period 2008:Q4-2009:Q2; it shows that the estimated coefficients in equations [5b] takes into accounts the expectations of a through of the business cycle embedded in the slope of the yield curve from the end of the second quarter of 2008. The bankruptcy of Lehman Brothers causes an acceleration in the fall of the Gross Domestic Product (Euro Area), but the model is not able to have an precise measure of this phenomenon even though it catches up the beginning of the recession. In the down side of the same figure (7.2) there is the out-of-sample forecast for the monthly $\Delta_{t-12}IPI_t$ series for the period 2009:1-2009:7; it seems to perform relatively better than the previous forecast.

6. The analysis according to macro-finance model

According to the previous condition [4], we can note that the difference between the nominal long-term and short-term rates is affected by the output growth, by the innovations in the inflation rate and by the capital market risk (both equity and bond risks). The short-term interest rate is determined by these same components on the basis of the risk adjusted Taylor rule [Taylor, 1993]. Therefore we can say that between the spread, the output, the innovation in the inflation rate, the short-term interest rate, the equity risk, the bond risk there is a relationship. We present a VAR model where all of these variables are endogenous without an identification framework in order to include the impact of the market risk premium on the macroeconomic system. This model is formed by six risk adjusted equations.

This different approach contains six risk adjusted equations; precisely it is formed by the following economic models:

[6.a] - risk adjusted Fisher condition;

[6.b] - risk adjusted Taylor Rule;

[6.c] – risk adjusted Inflation Targeting Model ;

[6.d] - risk adjusted Output Gap Model ;

[6.e] - Arbitrage Pricing Theory Model[15];

[6.f] – Bond Risk Premium Model.

In the model [6a]-[6f] the risk adjusted factor is the market risk premium (mrp_t) consisting of two components: the former is the equity risk premium embedded in the equity return, RETURN$_t$, the latter is represented by the bond risk premium, BRP$_t$.

[15] Ross, 1976.

Therefore, the second model, VAR2, can be represented by the following six equations with six endogenous variables and six lags (*j=1,...,6*):

[7.a] $SPREAD_t = \beta_{1,j}\ SPREAD_{t-j} + \eta_{1,j}\ SR_{t-j} + \kappa_{1,,j}\ IR_{t-j} + \delta_{1,j}\ OUTPUT_{t-j} + \theta_{1,,j}\ RETURN_{t-j} + \lambda_{1,,j}\ BRP_{t-j} + \alpha_1 + \varepsilon_{1,t}$

[7.b] $SR_t = \beta_{2,,j}\ SPREAD_{t-j} + \eta_{2,,j}\ SR_{t-j} + \kappa_{2,,j}\ IR_{t-j} + \delta_{2,,j}\ OUTPUT_{t-j} + \theta_{2,,j}\ RETURN_{t-j} + \lambda_{2,,j}\ BRP_{t-j} + \alpha_2 + \varepsilon_{2,t}$

[7.c] $IR_t = \beta_{3,,j}\ SPREAD_{t-j} + \eta_{3,,j}\ SR_{t-j} + \kappa_{3,,j}\ IR_{t-j} + \delta_{3,,j}\ OUTPUT_{t-j} + \theta_{3,,j}\ RETURN_{t-j} + \lambda_{3,,j}\ BRP_{t-j} + \alpha_3 + \varepsilon_{3,t}$

[7.d] $OUTPUT_t = \beta_{4,,j}\ SPREAD_{t-j} + \eta_{4,,j}\ SR_{t-j} + \kappa_{4,,j}\ IR_{t-j} + \delta_{4,,j}\ OUTPUT_{t-j} + \theta_{4,,j}\ RETURN_{t-j} + \lambda_{4,,j}\ BRP_{t-j} + \alpha_4 + \varepsilon_{4,t}$

[7.e] $RETURN_t = \beta_{5,,j}\ SPREAD_{t-j} + \eta_{5,,j}\ SR_{t-j} + \kappa_{5,,j}\ IR_{t-j} + \delta_{5,,j}\ OUTPUT_{t-j} + \theta_{5,,j}\ RETURN_{t-j} + \lambda_{5,,j}\ BRP_{t-j} + \alpha_5 + \varepsilon_{5,t}$

[7.f] $BRP_t = \beta_{6,,j}\ SPREAD_{t-j} + \eta_{6,,j}\ SR_{t-j} + \kappa_{6,,j}\ IR_{t-j} + \delta_{6,,j}\ OUTPUT_{t-j} + \theta_{6,,j}\ RETURN_{t-j} + \lambda_{6,,j}\ BRP_{t-j} + \alpha_6 + \varepsilon_{6,t}$

where $SPREAD_t$ and $OUTPUT_t$ are as previously, while SR_t is short-term interest rate, IR_t the inflation rate, $RETURN_t$ the equity return, BRP_t the bond risk premium. β , η , κ , δ , θ , λ are the parameters of the six lagged endogenous variables.

For the estimation of VAR2 model we take into account many other factors affecting the financial and economic system, not only the slope of the yield curve and the GDP annual growth rate.

First of all, Fisher condition also implies that the market risk premium and the innovation in the inflation rate cause changes in the spread between the long-term and short-term interest rates. For this reason we consider the annual growth rate of Dow Jones Euro Stoxx 50 Price Index; this is determined as:

$$RETURN_t = [\Delta_{t-e}\ DOW50_{\ t\ =} \log(DOW50_{\ t}) - \log(DOW50_{\ t-4})]$$

while the risk premium of the Bond Market is empirically identified by *VOLATILITY* variable[16]. We assume as a proxy of the inflation innovation in the equations [7.a]-[7.f] the difference between HICIP and an annual rate of 2 per cent, the upper target which European Central Bank is committed to keep in the medium-term.

[16] These two variables are respectively the equity and the bond components of the Market Risk Premium, mrp_t (see equation [4]).

Fig. 8 - IMPULSE RESPONSE FUNCTIONS FOR GDP IN VAR2 MODEL

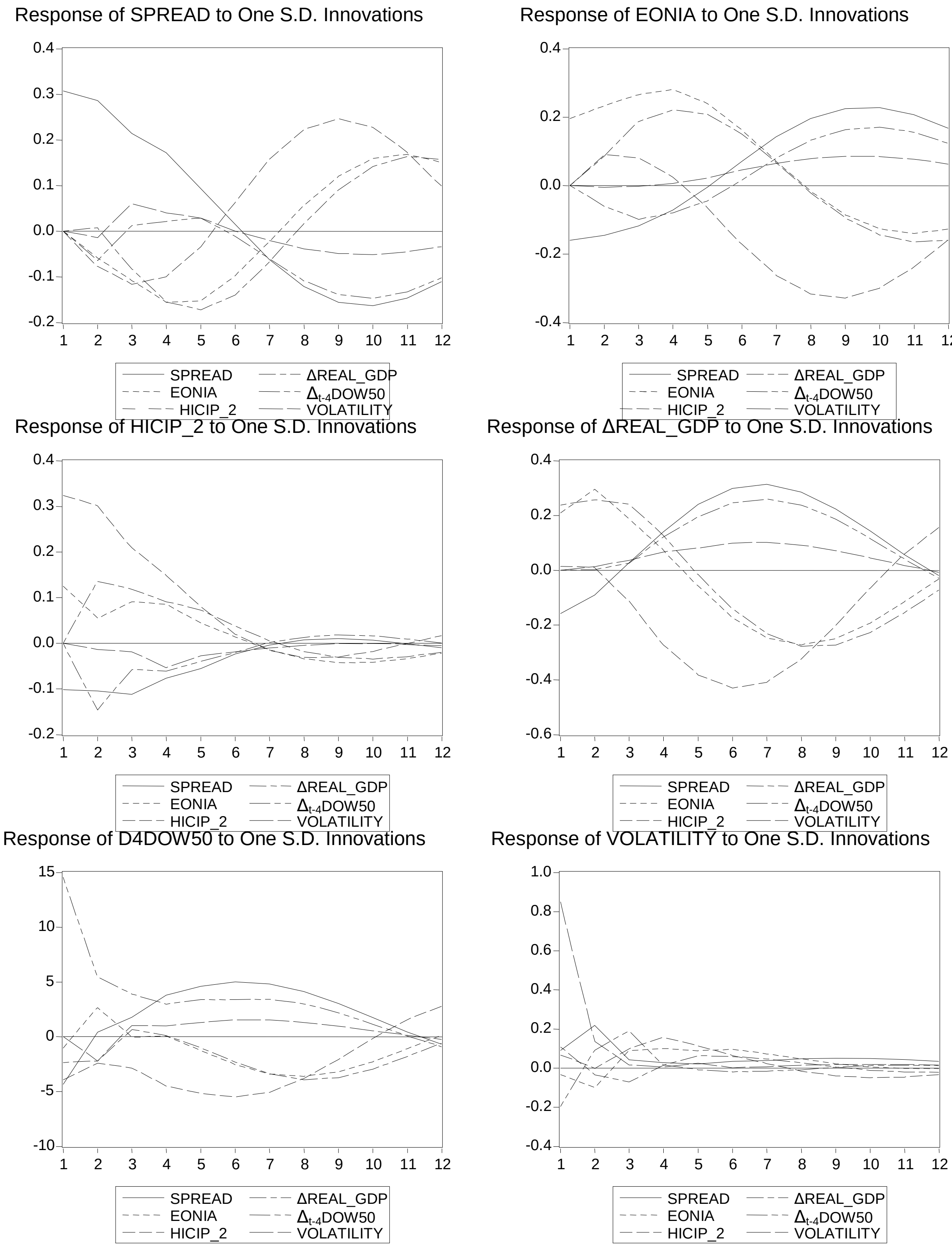
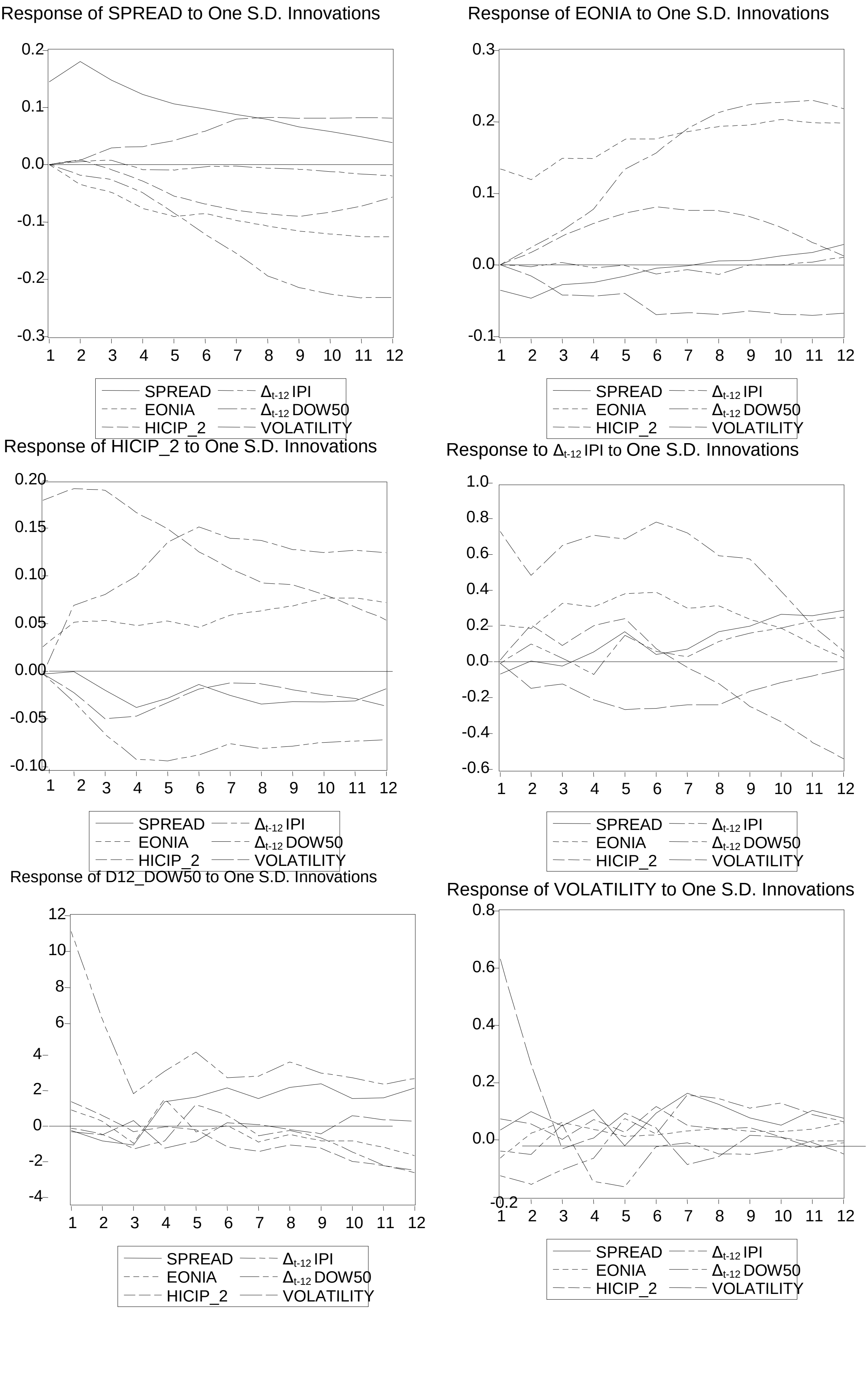


Figure 9 - IMPULSE RESPONSE FUNCTIONS FOR IPI IN VAR2 MODEL



The statistics on the estimated coefficients of VAR2 model for ΔREAL_GDP$_t$ quarterly series are reported in Appendix (see the Tab. A1.V of Appendix1)[17]. In particular, it can see that the coefficients of the equation [7d] show statistical significance and have the theoretically predicted sign. The estimation of the coefficients of equations [7.a]-[7.f] on monthly $\Delta_{t-12}IPI_t$ series provides tatistical performance less performing than the one on quarterly series. Both the VAR estimations with six lag of the quarterly GDP series and of the monthly IPI series are convergent with the results obtained on the quarterly series (see Appendix1, Tables A1.VI)[18]. The impulse response functions of both the models are plotted in Figg. 8 and 9, respectively, and confirm the previous conclusions. This enable us to present in Fig. 10 the same out-of-sample exercises in a dynamic context for $\Delta REAL\_GDP$ (for period 2008:4-2009:2) and for $\Delta_{t-12}IPI_t$ (period 2009:1-2009:7). Both the forecasts provides results more performing than the previous exercise.

7. Concluding remarks

The paper aims to test the predictive power of the yield spreads for forecast the future growth of the real activities in the European Union in the 1995-2008 period. With this regard we present a version of yield curve model more explicitly founded than one proposed by the typical approach. This model provides a contribution of efficiency in the estimates, on monthly frequency expecially, and it allows an further in-depth analysis about the impact on the output growth of the monetary and the financial dynamics.

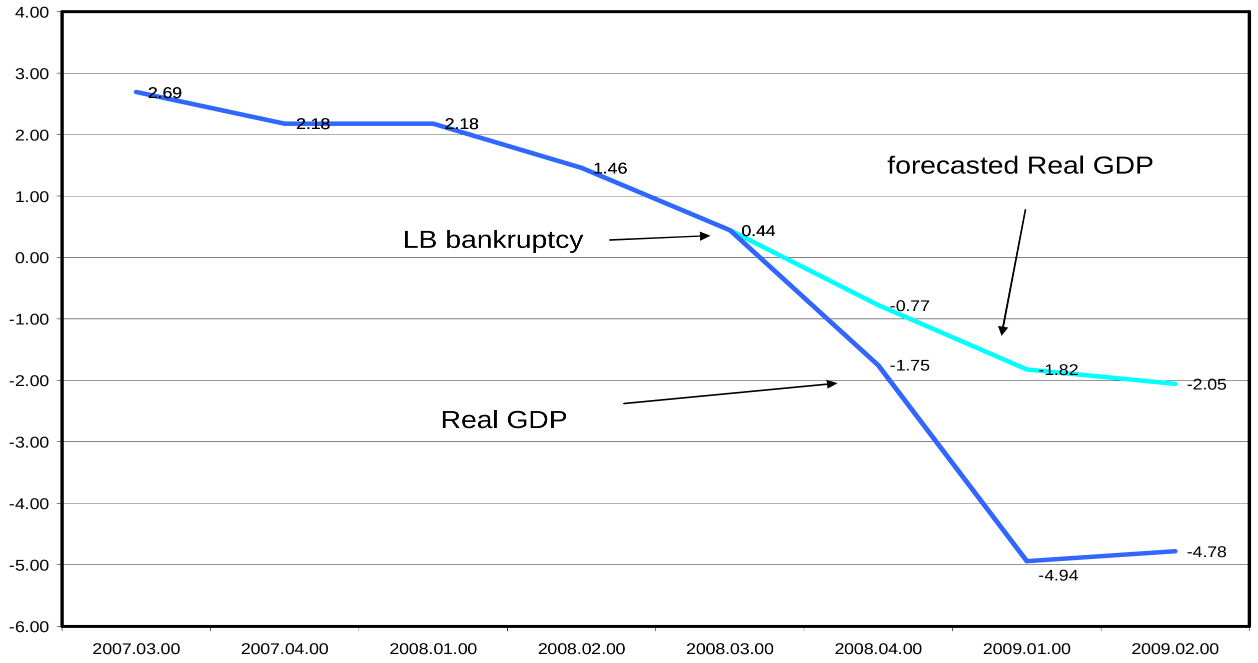
We produce the VAR estimations and the out-of-sample forecasts both for the Gross Domestic Product (GDP) quarterly series and for Industrial Production Index (IPI) monthly series of the EU (at 16 countries). The estimates confirm the statistical significance of the positive relationship between the monthly changes in the slope of the yields curve and the GDP (or IPI) growth rate on the same quarter (month) of the previous year. In particular the impulse response function indicates that an innovation in the change of the spread between the long-term interest rate and the short-term one is persistent on the IPI growth rate from the 8th month and on the GDP growth rate from the 3th quarter. The quarterly estimations show statistical significance while the monthly

[17] In the equations [7.a]-[7.f] we use EONIA$_t$ variable as a proxy of the short-term rate. This solution is consistent with an econometric estimation of the parameters of a risk adjusted Talyor Rule.

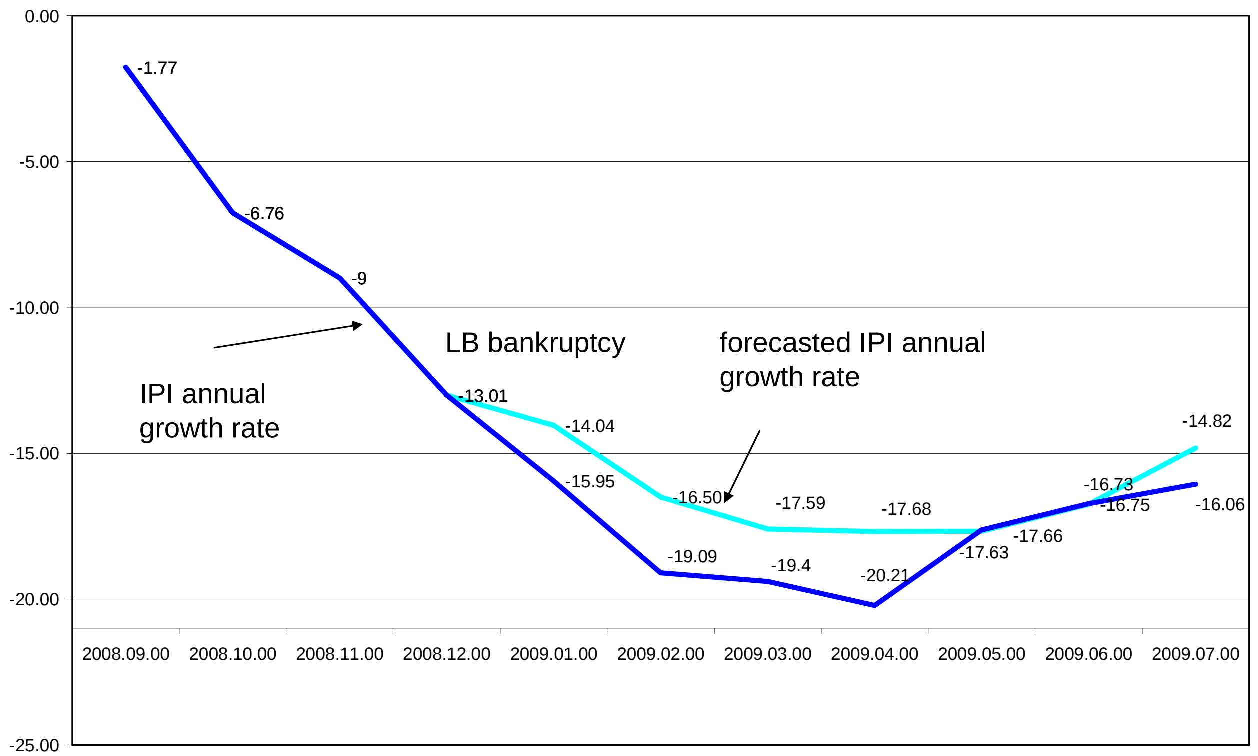
[18] However the standard errors of each coefficient of the equations [5a]-[5b] on monthly series are larger than the quarterly estimated ones.

Fig. 10 - OUT-OF-SAMPLE FORECAST ACCORDING TO VAR2 MODEL

10.1 – QUARTERLY GDP SERIES



10.2 – MONTHLY IPI SERIES



ones show standard errors larger. Moreover, from the analysis it is possible verify that the IPI estimates and forecasts perform better than the GDP estimates and forecasts and that our model version performs weakly better than one of the standard approach. The monthly frequency of the IPI series seems to catch up the signals of the changes in the business cycle better than quarterly frequency of the GDP series.

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Appendix1

Tab. A1.I - Correlation and statistics of *IPI_t* and *GDP_t* in logs (Euro Area).

Correlation

	LIPI	LGDP
LIPI	1	0.8892
LGDP	0.8892	1

Statistics

	LIPI	LGDP
Mean	4.567787	4.628017
Median	4.570423	4.636572
Maximum	4.700208	4.750741
Minimum	4.425445	4.475972
Std. Dev.	0.072808	0.080089
Skewness	-0.070806	-0.288259
Kurtosis	2.348496	2.034569
Jarque-Bera	1.000149	2.844967
Probability	0.606485	0.241114
Observations	54	54

Tab. A1.II - Correlation and statistics of *Δ_{t-12} IPI_t* and *Δ REAL_GDP* (Euro Area).

Correlation

	Δ_{t-12} IPI	ΔREAL_GDP
ΔREAL_GDP	0.959723	1
Δ_{t-12} IPI	1	0.959723

Statistics

	Δ_{t-12} IPI	ΔREAL_GDP
Mean	1.006296	1.860185
Median	1.835	2.025
Maximum	5.92	4.59
Minimum	-19.4	-4.94
Std. Dev.	4.850362	1.741143
Skewness	-2.67573	-2.11124
Kurtosis	10.94694	9.278514
Jarque-Bera	206.532	128.8104
Probability	0	0
Observations	54	54

Tab. A1.III - Estimated VAR equations [5.a]-[5.b], GDP quarterly series (Euro Area).

Sample(adjusted): 1996:3 2008:4
Included observations: 50 after adjusting endpoints
Standard errors & t-statistics in parentheses

	SPREAD	ΔREAL_GDP
SPREAD(-1)	0.849458	0.533289
	(0.14985)	(0.17471)
	(5.66889)	(3.05247)
SPREAD(-2)	-0.137119	-0.224990
	(0.15548)	(0.18127)
	(-0.88192)	(-1.24115)
ΔREAL_GDP(-1)	-0.026141	1.418446
	(0.13497)	(0.15736)
	(-0.19368)	(9.01407)
ΔREAL_GDP(-2)	-0.176414	-0.388200
	(0.14790)	(0.17244)
	(-1.19279)	(-2.25124)
C	0.752772	-0.465340
	(0.20803)	(0.24254)
	(3.61859)	(-1.91857)
R-squared	0.803460	0.872148
Adj. R-squared	0.785990	0.860783
Sum sq. resids	6.173742	8.392353
S.E. equation	0.370397	0.431853
Log likelihood	-18.65398	-26.32937
Akaike AIC	-18.45398	-26.12937
Schwarz SC	-18.26278	-25.93817
Mean dependent	1.112000	2.149200
S.D. dependent	0.800666	1.157416
Determinant Residual Covariance		0.019376
Log Likelihood		-43.30065
Akaike Information Criteria		-42.90065
Schwarz Criteria		-42.51825

TABLE A1.IV - Estimated VAR equations [5.a]-[5.b], IPI monthly series (Euro Area).

Sample(adjusted): 1995:07 2008:12
Included observations: 162 after adjusting endpoints
Standard errors & t-statistics in parentheses

	SPREAD	Δ_{t-12} IPI
SPREAD(-1)	1.279885	0.031590
	(0.08166)	(0.48179)
	(15.6726)	(0.06557)
SPREAD(-2)	-0.512008	0.255649
	(0.13231)	(0.78058)
	(-3.86981)	(0.32751)
SPREAD(-3)	0.204487	0.800375
	(0.13843)	(0.81670)
	(1.47718)	(0.98001)
SPREAD(-4)	-0.014183	-0.422760
	(0.13231)	(0.78057)
	(-0.10720)	(-0.54161)
SPREAD(-5)	0.002319	-1.265008
	(0.12503)	(0.73764)
	(0.01855)	(-1.71493)
SPREAD(-6)	0.007851	0.958435
	(0.07989)	(0.47132)
	(0.09828)	(2.03349)
Δ_{t-12} IPI (-1)	-0.032055	0.747547
	(0.01411)	(0.08327)
	(-2.27099)	(8.97703)
Δ_{t-12} IPI (-2)	0.013275	0.439016
	(0.01766)	(0.10421)
	(0.75152)	(4.21282)
Δ_{t-12} IPI (-3)	-0.015684	0.166935
	(0.01816)	(0.10712)
	(-0.86376)	(1.55834)
Δ_{t-12} IPI (-4)	-0.002114	-0.241149
	(0.01867)	(0.11012)
	(-0.11327)	(-2.18987)
Δ_{t-12} IPI (-5)	-0.002392	-0.029239
	(0.01782)	(0.10515)
	(-0.13421)	(-0.27807)
Δ_{t-12} IPI (-6)	0.013494	-0.089717
	(0.01532)	(0.09039)
	(0.88078)	(-0.99260)
C	0.079732	-0.508507
	(0.03851)	(0.22720)
	(2.07036)	(-2.23810)
R-squared	0.959797	0.886378
Adj. R-squared	0.956559	0.877228
Sum sq. resids	4.119063	143.3695
S.E. equation	0.166267	0.980924
Log likelihood	67.56159	-219.9722
Akaike AIC	67.72209	-219.8117
Schwarz SC	67.96986	-219.5639
Mean dependent	1.193827	1.866975
S.D. dependent	0.797729	2.799530
Determinant Residual Covariance		0.022502
Log Likelihood		-152.4098

Tab. A1.V - Estimated VAR equations [7.a]-[7.f], GDP quarterly series (Euro Area).

Sample(adjusted): 1996:3 2008:4
Included observations: 50 after adjusting endpoints
Standard errors & t-statistics in parentheses

	SPREAD	EONIA	HICIP-2	ΔREAL_GDP	ΔT-4DOW50	VOLATILITY
SPREAD(-1)	0.701975	0.060995	-0.384416	0.455656	14.91301	0.561117
	(0.18784)	(0.15435)	(0.22083)	(0.21660)	(9.70097)	(0.54088)
	(3.73701)	(0.39516)	(-1.74075)	(2.10363)	(1.53727)	(1.03742)
SPREAD(-2)	-0.072576	0.089384	0.355707	-0.277195	-4.211229	0.101625
	(0.18504)	(0.15205)	(0.21754)	(0.21338)	(9.55635)	(0.53281)
	(-0.39221)	(0.58785)	(1.63512)	(-1.29910)	(-0.44067)	(0.19073)
EONIA(-1)	-0.135869	0.688287	-0.787399	0.380967	21.62361	-0.341843
	(0.33964)	(0.27909)	(0.39929)	(0.39164)	(17.5404)	(0.97796)
	(-0.40004)	(2.46619)	(-1.97200)	(0.97274)	(1.23279)	(-0.34955)
EONIA(-2)	0.129769	0.131851	0.716479	-0.493110	-21.57456	0.703513
	(0.32143)	(0.26413)	(0.37788)	(0.37065)	(16.6000)	(0.92553)
	(0.40372)	(0.49920)	(1.89604)	(-1.33041)	(-1.29968)	(0.76012)
HICIP-2(-1)	-0.290112	0.212089	0.787424	-0.016227	-2.531786	0.072370
	(0.15668)	(0.12875)	(0.18420)	(0.18067)	(8.09150)	(0.45114)
	(-1.85163)	(1.64735)	(4.27494)	(-0.08981)	(-0.31289)	(0.16041)
HICIP-2(-2)	0.114381	-0.165188	-0.003256	-0.292934	-3.109295	0.657223
	(0.16904)	(0.13890)	(0.19873)	(0.19492)	(8.72989)	(0.48673)
	(0.67665)	(-1.18923)	(-0.01638)	(-1.50283)	(-0.35617)	(1.35027)
ΔREAL_GDP(-1)	-0.004634	0.321066	0.474741	1.074805	-4.755787	-0.138424
	(0.17406)	(0.14303)	(0.20463)	(0.20071)	(8.98912)	(0.50119)
	(-0.02662)	(2.24478)	(2.32001)	(5.35501)	(-0.52906)	(-0.27619)
ΔREAL_GDP(-2)	-0.196860	0.029840	-0.218170	-0.252922	5.726020	0.116864
	(0.15613)	(0.12830)	(0.18355)	(0.18004)	(8.06335)	(0.44957)
	(-1.26084)	(0.23258)	(-1.18858)	(-1.40481)	(0.71013)	(0.25995)
ΔT-4DOW50(-1)	-0.004671	-0.004225	-0.010230	0.000357	0.340670	0.008446
	(0.00321)	(0.00264)	(0.00378)	(0.00370)	(0.16589)	(0.00925)
	(-1.45416)	(-1.60049)	(-2.70886)	(0.09640)	(2.05358)	(0.91315)
ΔT-4DOW50(-2)	0.003273	-0.000120	0.002153	0.005269	0.326839	0.011042
	(0.00358)	(0.00294)	(0.00421)	(0.00413)	(0.18478)	(0.01030)
	(0.91488)	(-0.04097)	(0.51192)	(1.27714)	(1.76883)	(1.07183)
VOLATILITY(-1)	-0.017171	-0.006164	-0.015911	0.015668	-2.614500	0.160719
	(0.05739)	(0.04715)	(0.06746)	(0.06617)	(2.96360)	(0.16524)
	(-0.29922)	(-0.13072)	(-0.23584)	(0.23678)	(-0.88221)	(0.97267)
VOLATILITY(-2)	0.067340	-0.008263	-0.052910	0.034281	2.919187	0.026158
	(0.05207)	(0.04278)	(0.06121)	(0.06004)	(2.68884)	(0.14992)
	(1.29338)	(-0.19313)	(-0.86442)	(0.57100)	(1.08567)	(0.17449)
C	0.617778	-0.289836	0.121900	0.211376	-13.39809	2.074933
	(0.37556)	(0.30860)	(0.44151)	(0.43306)	(19.3952)	(1.08138)
	(1.64496)	(-0.93919)	(0.27609)	(0.48810)	(-0.69079)	(1.91879)
R-squared	0.849467	0.912429	0.689162	0.904215	0.609881	0.385947
Adj. R-squared	0.800645	0.884027	0.588350	0.873150	0.483356	0.186795
Sum sq. resids	4.728583	3.192812	6.535302	6.287402	12611.49	39.20420
S.E. equation	0.357491	0.293755	0.420273	0.412225	18.46215	1.029356
Log likelihood	-11.98699	-2.168897	-20.07681	-19.11005	-209.2054	-64.86595
Akaike AIC	-11.46699	-1.648897	-19.55681	-18.59005	-208.6854	-64.34595
Schwarz SC	-10.96987	-1.151771	-19.05969	-18.09292	-208.1883	-63.84882
Mean dependent	1.112000	3.283800	0.048000	2.149200	9.049800	5.224200
S.D. dependent	0.800666	0.862597	0.655040	1.157416	25.68543	1.141473

Determinant Residual Covariance	0.003289
Log Likelihood	-282.7524
Akaike Information Criteria	-279.6324

Tab. A1.VI - Estimated VAR equations [7.a]-[7.f], IPI monthly series (Euro Area).

Sample(adjusted): 1995:07 2008:12
Included observations: 162 after adjusting endpoints
Standard errors & t-statistics in parentheses

	SPREAD	EONIA	HICIP-2	? T-12 IPI	? T-12 DOW50	VOLATILITY
SPREAD(-1)	1.179193	-0.104556	0.074214	0.424248	-3.875682	0.667265
	(0.09138)	(0.08752)	(0.11623)	(0.48991)	(7.14184)	(0.41299)
	(12.9041)	(-1.19471)	(0.63853)	(0.86596)	(-0.54267)	(1.61570)
SPREAD(-2)	-0.484393	0.280744	-0.238985	-0.137729	0.206907	-0.535581
	(0.14034)	(0.13440)	(0.17849)	(0.75237)	(10.9678)	(0.63423)
	(-3.45167)	(2.08888)	(-1.33893)	(-0.18306)	(0.01886)	(-0.84445)
SPREAD(-3)	0.221756	-0.155683	0.072234	0.684432	20.50495	0.867317
	(0.14964)	(0.14331)	(0.19032)	(0.80223)	(11.6947)	(0.67627)
	(1.48197)	(-1.08636)	(0.37954)	(0.85316)	(1.75335)	(1.28251)
SPREAD(-4)	-0.073876	0.112746	0.141840	0.002937	-12.90291	-1.348473
	(0.14698)	(0.14077)	(0.18695)	(0.78801)	(11.4874)	(0.66428)
	(-0.50261)	(0.80094)	(0.75873)	(0.00373)	(-1.12322)	(-2.02998)
SPREAD(-5)	0.103461	-0.071072	-0.073364	-1.399680	9.210657	1.477910
	(0.13838)	(0.13252)	(0.17600)	(0.74186)	(10.8147)	(0.62538)
	(0.74768)	(-0.53630)	(-0.41685)	(-1.88671)	(0.85168)	(2.36323)
SPREAD(-6)	-0.048221	-0.015801	-0.003472	1.068051	-7.598777	-0.282876
	(0.09150)	(0.08763)	(0.11637)	(0.49054)	(7.15089)	(0.41351)
	(-0.52702)	(-0.18032)	(-0.02983)	(2.17732)	(-1.06263)	(-0.68408)
EONIA(-1)	-0.229776	0.812019	0.033634	0.035739	-0.302426	0.586698
	(0.10108)	(0.09681)	(0.12857)	(0.54193)	(7.90016)	(0.45684)
	(-2.27312)	(8.38790)	(0.26161)	(0.06595)	(-0.03828)	(1.28425)
EONIA(-2)	0.160538	0.266502	-0.003281	1.060061	-4.054411	0.056695
	(0.12754)	(0.12214)	(0.16221)	(0.68374)	(9.96742)	(0.57638)
	(1.25877)	(2.18193)	(-0.02023)	(1.55038)	(-0.40677)	(0.09836)
EONIA(-3)	-0.093475	-0.088399	-0.163539	-0.720338	16.36230	-0.115914
	(0.12835)	(0.12292)	(0.16325)	(0.68812)	(10.0312)	(0.58007)
	(-0.72828)	(-0.71914)	(-1.00178)	(-1.04682)	(1.63113)	(-0.19983)
EONIA(-4)	0.100638	0.062646	0.121083	0.129889	-17.55057	-0.046091
	(0.12879)	(0.12335)	(0.16381)	(0.69049)	(10.0658)	(0.58207)
	(0.78139)	(0.50789)	(0.73917)	(0.18811)	(-1.74358)	(-0.07919)
EONIA(-5)	0.147343	-0.066288	-0.082672	0.274951	10.66369	-0.614290
	(0.12654)	(0.12118)	(0.16094)	(0.67839)	(9.88944)	(0.57187)
	(1.16443)	(-0.54700)	(-0.51368)	(0.40530)	(1.07829)	(-1.07417)
EONIA(-6)	-0.096835	-0.015465	0.089401	-0.694428	-5.139587	0.364739
	(0.09981)	(0.09558)	(0.12694)	(0.53508)	(7.80027)	(0.45106)
	(-0.97023)	(-0.16179)	(0.70427)	(-1.29780)	(-0.65890)	(0.80862)
HICIP-2(-1)	0.038183	0.105770	1.095902	1.118003	-0.006941	0.179253
	(0.07039)	(0.06741)	(0.08953)	(0.37739)	(5.50145)	(0.31813)
	(0.54244)	(1.56894)	(12.2406)	(2.96248)	(-0.00126)	(0.56346)
HICIP-2(-2)	-0.109313	0.016317	-0.173724	-1.391301	-1.380248	-0.204543
	(0.10544)	(0.10098)	(0.13411)	(0.56531)	(8.24092)	(0.47654)
	(-1.03669)	(0.16158)	(-1.29537)	(-2.46113)	(-0.16749)	(-0.42922)
HICIP-2(-3)	0.040508	-0.047448	-0.006626	0.717379	3.229292	0.592113
	(0.10665)	(0.10214)	(0.13565)	(0.57179)	(8.33536)	(0.48201)
	(0.37981)	(-0.46453)	(-0.04885)	(1.25462)	(0.38742)	(1.22844)
HICIP-2(-4)	-0.044239	-0.018224	-0.055013	-0.158021	-6.100906	-0.661652
	(0.10891)	(0.10430)	(0.13852)	(0.58389)	(8.51177)	(0.49221)
	(-0.40620)	(-0.17472)	(-0.39715)	(-0.27064)	(-0.71676)	(-1.34426)
HICIP-2(-5)	0.046182	-0.029857	-0.067920	-0.956219	-3.421459	0.702882
	(0.10747)	(0.10292)	(0.13669)	(0.57616)	(8.39909)	(0.48569)
	(0.42973)	(-0.29010)	(-0.49691)	(-1.65964)	(-0.40736)	(1.44718)
HICIP-2(-6)	-0.048469	0.011581	0.128847	0.248709	4.815903	-0.581574
	(0.07688)	(0.07363)	(0.09779)	(0.41219)	(6.00878)	(0.34747)
	(-0.63042)	(0.15728)	(1.31764)	(0.60339)	(0.80148)	(-1.67375)
? T-12 IPI(-1)	-0.023027	0.028591	0.091927	0.627656	-0.400003	-0.139009
	(0.01770)	(0.01695)	(0.02251)	(0.09490)	(1.38337)	(0.08000)
	(-1.30093)	(1.68664)	(4.08330)	(6.61415)	(-0.28915)	(-1.73771)
? T-12 IPI(-2)	0.019388	-0.003289	-0.062226	0.347335	-0.813592	-0.024436
	(0.02104)	(0.02015)	(0.02676)	(0.11279)	(1.64427)	(0.09508)
	(0.92155)	(-0.16322)	(-2.32544)	(3.07940)	(-0.49481)	(-0.25700)
? T-12 IPI(-3)	-0.009786	0.003532	-0.021646	0.136046	0.748997	0.055823
	(0.02064)	(0.01976)	(0.02625)	(0.11064)	(1.61288)	(0.09327)
	(-0.47422)	(0.17868)	(-0.82469)	(1.22963)	(0.46439)	(0.59853)

Δ T-12 IPI(-4)	-0.013109	0.039861	0.033662	-0.189721	2.533220	0.189505
	(0.02067)	(0.01980)	(0.02629)	(0.11084)	(1.61575)	(0.09343)
	(-0.63411)	(2.01324)	(1.28020)	(-1.71172)	(1.56783)	(2.02824)
Δ T-12 IPI(-5)	-0.002376	-0.021012	0.022870	0.036981	-0.382505	-0.111548
	(0.02055)	(0.01968)	(0.02614)	(0.11019)	(1.60638)	(0.09289)
	(-0.11562)	(-1.06742)	(0.87482)	(0.33560)	(-0.23812)	(-1.20085)
Δ T-12 IPI(-6)	-0.000466	-0.011410	-0.035457	-0.042150	-1.022229	0.140851
	(0.01721)	(0.01648)	(0.02189)	(0.09226)	(1.34496)	(0.07777)
	(-0.02706)	(-0.69233)	(-1.61994)	(-0.45686)	(-0.76005)	(1.81102)
Δ T-12 DOW50(-1)	0.000513	-0.000330	-0.002793	0.009019	0.562868	-0.003094
	(0.00116)	(0.00111)	(0.00147)	(0.00620)	(0.09041)	(0.00523)
	(0.44373)	(-0.29753)	(-1.89805)	(1.45427)	(6.22593)	(-0.59174)
Δ T-12 DOW50(-2)	0.000279	0.000489	-0.002324	-0.006590	-0.119950	0.009223
	(0.00135)	(0.00129)	(0.00172)	(0.00725)	(0.10567)	(0.00611)
	(0.20598)	(0.37775)	(-1.35109)	(-0.90908)	(-1.13509)	(1.50932)
Δ T-12 DOW50(-3)	-0.001835	-0.000113	0.000152	-0.005099	0.267674	-0.019625
	(0.00135)	(0.00129)	(0.00172)	(0.00725)	(0.10567)	(0.00611)
	(-1.35714)	(-0.08724)	(0.08822)	(-0.70339)	(2.53316)	(-3.21174)
Δ T-12 DOW50(-4)	0.000786	0.000832	0.001697	0.015786	0.067201	0.004120
	(0.00137)	(0.00131)	(0.00174)	(0.00733)	(0.10690)	(0.00618)
	(0.57454)	(0.63479)	(0.97545)	(2.15271)	(0.62865)	(0.66650)
Δ T-12 DOW50(-5)	0.000592	-0.002146	-0.002008	-0.008623	-0.031764	0.001913
	(0.00138)	(0.00132)	(0.00176)	(0.00742)	(0.10812)	(0.00625)
	(0.42824)	(-1.61983)	(-1.14130)	(-1.16262)	(-0.29378)	(0.30592)
Δ T-12 DOW50(-6)	-0.001063	0.001345	0.001909	-0.001778	0.088974	0.004472
	(0.00121)	(0.00116)	(0.00154)	(0.00648)	(0.09443)	(0.00546)
	(-0.87998)	(1.16250)	(1.24248)	(-0.27455)	(0.94224)	(0.81902)
VOLATILITY(-1)	0.012065	-0.023985	-0.031454	-0.222853	-0.298344	0.419850
	(0.01927)	(0.01845)	(0.02451)	(0.10330)	(1.50584)	(0.08708)
	(0.62619)	(-1.29983)	(-1.28354)	(-2.15739)	(-0.19812)	(4.82155)
VOLATILITY(-2)	0.017762	-0.025767	-0.007715	0.082841	1.223028	-0.247311
	(0.01859)	(0.01780)	(0.02364)	(0.09966)	(1.45278)	(0.08401)
	(0.95551)	(-1.44741)	(-0.32634)	(0.83126)	(0.84185)	(-2.94386)
VOLATILITY(-3)	-0.017932	0.015706	0.014739	-0.136669	-2.826182	0.132338
	(0.01903)	(0.01822)	(0.02420)	(0.10200)	(1.48697)	(0.08599)
	(-0.94247)	(0.86196)	(0.60906)	(-1.33985)	(-1.90063)	(1.53905)
VOLATILITY(-4)	0.017628	0.010321	0.025677	-0.003655	1.373316	0.057664
	(0.01937)	(0.01855)	(0.02463)	(0.10383)	(1.51365)	(0.08753)
	(0.91021)	(0.55642)	(1.04238)	(-0.03520)	(0.90729)	(0.65879)
VOLATILITY(-5)	0.002462	-0.022383	0.019163	-0.029027	0.186125	0.015186
	(0.01888)	(0.01808)	(0.02401)	(0.10120)	(1.47525)	(0.08531)
	(0.13040)	(-1.23817)	(0.79819)	(-0.28683)	(0.12617)	(0.17802)
VOLATILITY(-6)	0.010620	0.016710	0.005797	-0.020280	-0.274649	-0.165381
	(0.01777)	(0.01702)	(0.02261)	(0.09529)	(1.38905)	(0.08032)
	(0.59755)	(0.98169)	(0.25646)	(-0.21283)	(-0.19772)	(-2.05892)
C	0.000234	0.101079	-0.103911	0.714884	-3.260020	2.002962
	(0.10671)	(0.10220)	(0.13573)	(0.57211)	(8.34010)	(0.48228)
	(0.00219)	(0.98904)	(-0.76559)	(1.24955)	(-0.39089)	(4.15311)
R-squared	0.966913	0.981229	0.911034	0.922780	0.783600	0.632309
Adj. R-squared	0.957383	0.975822	0.885411	0.900541	0.721277	0.526414
Sum sq. resids	3.389994	3.109267	5.483891	97.43737	20706.38	69.24051
S.E. equation	0.164681	0.157715	0.209454	0.882892	12.87055	0.744261
Log likelihood	83.34018	90.34193	44.38027	-188.6887	-622.7667	-161.0172
Akaike AIC	83.79697	90.79872	44.83706	-188.2319	-622.3099	-160.5604
Schwarz SC	84.50216	91.50391	45.54225	-187.5267	-621.6047	-159.8552
Mean dependent	1.193827	3.469198	0.066667	1.866975	9.703765	5.200617
S.D. dependent	0.797729	1.014303	0.618755	2.799530	24.37872	1.081498
Determinant Residual Covariance		0.000338				
Log Likelihood		-731.7952				
Akaike Information Criteria		-729.0545				
Schwarz Criteria		-724.8233				

Appendix2

Tab. A2.I - Estimated VEC equations, GDP quarterly series (Euro Area).

Sample(adjusted): 1996:4 2008:4
Included observations: 49 after adjusting endpoints
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
SPREAD(-1)	1.000000	
DREAL_GDP(-1)	0.183773	
	(0.18214)	
	(1.00894)	
C	-1.630281	
	(0.42084)	
	(-3.87389)	
Error Correction:	Δ (SPREAD)	Δ (ΔREAL_GDP)
CointEq1	-0.200149	0.358580
	(0.10136)	(0.11680)
	(-1.97461)	(3.07007)
Δ (SPREAD(-1))	0.176204	0.263288
	(0.15370)	(0.17711)
	(1.14643)	(1.48662)
Δ (SPREAD(-2))	0.112854	-0.194565
	(0.16098)	(0.18550)
	(0.70102)	(-1.04885)
Δ (DREAL_GDP(-1))	0.133316	0.385774
	(0.14855)	(0.17117)
	(0.89746)	(2.25372)
Δ (DREAL_GDP(-2))	-0.309717	-0.053995
	(0.15379)	(0.17721)
	(-2.01391)	(-0.30470)
R-squared	0.295957	0.487513
Adj. R-squared	0.231953	0.440923
Sum sq. resids	6.161914	8.181780
S.E. equation	0.374224	0.431219
Log likelihood	-18.72888	-25.67518
Akaike AIC	-18.52480	-25.47110
Schwarz SC	-18.33176	-25.27805
Mean dependent	-0.034082	-0.068980
S.D. dependent	0.427010	0.576716
Determinant Residual Covariance		0.020156
Log Likelihood		-43.40156
Akaike Information Criteria		-42.87094
Schwarz Criteria		-42.36903

Tab. A2.II - Estimated VEC equations, IPI monthly series (Euro Area).

Sample(adjusted): 1995:08 2008:12
Included observations: 161 after adjusting endpoints
Standard errors & t-statistics in parentheses

Cointegrating Eq:	CointEq1	
SPREAΔ(-1)	1.000000	
Δ12_IPI(-1)	0.685327	
	(0.39312)	
	(1.74331)	
C	-2.323994	
	(0.70786)	
	(-3.28312)	
Error Correction:	**Δ(SPREAD)**	**Δ(Δ12_IPI)**
CointEq1	-0.036663	0.010177
	(0.01139)	(0.06924)
	(-3.21798)	(0.14698)
Δ(SPREAΔ(-1))	0.309850	0.054052
	(0.07998)	(0.48609)
	(3.87386)	(0.11120)
Δ(SPREAΔ(-2))	-0.187766	0.300022
	(0.08607)	(0.52307)
	(-2.18155)	(0.57358)
Δ(SPREAΔ(-3))	-0.009456	1.012755
	(0.08706)	(0.52911)
	(-0.10861)	(1.91408)
Δ(SPREAΔ(-4))	0.015150	0.641137
	(0.08616)	(0.52363)
	(0.17583)	(1.22440)
Δ(SPREAΔ(-5))	-0.011294	-0.785671
	(0.08149)	(0.49525)
	(-0.13859)	(-1.58642)
Δ(SPREAΔ(-6))	0.006244	0.217488
	(0.07886)	(0.47924)
	(0.07918)	(0.45382)
Δ(Δ12_IPI(-1))	-0.005511	-0.203281
	(0.01577)	(0.09584)
	(-0.34949)	(-2.12112)
Δ(Δ12_IPI(-2))	0.007618	0.249638
	(0.01622)	(0.09858)
	(0.46962)	(2.53231)
Δ(Δ12_IPI(-3))	-0.004668	0.415316
	(0.01699)	(0.10325)
	(-0.27476)	(4.02237)
Δ(Δ12_IPI(-4))	-0.008985	0.173572
	(0.01685)	(0.10238)
	(-0.53332)	(1.69531)
Δ(Δ12_IPI(-5))	-0.013918	0.153081
	(0.01732)	(0.10523)
	(-0.80381)	(1.45475)
Δ(Δ12_IPI(-6))	-0.008410	0.061265
	(0.01550)	(0.09418)
	(-0.54266)	(0.65049)
R-squared	0.298576	0.245150
Adj. R-squared	0.241704	0.183945
Sum sq. resids	4.095407	151.2543
S.E. equation	0.166348	1.010935
Log likelihood	67.10973	-223.4226
Akaike AIC	67.27122	-223.2611
Schwarz SC	67.52003	-223.0123
Mean dependent	-0.007391	-0.105528
S.D. dependent	0.191029	1.119086
Determinant Residual Covariance		0.023896
Log Likelihood		-156.3092
Akaike Information Criteria		-155.9490
Schwarz Criteria		-155.3940