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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 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 jump out arising from Lehman Brother's unexpected crash and the becoming next fine tuning process.

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

JEL Classification: E43, E44, E47, E52

1. Introduction

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 consistently 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 rates of the European Union. We use also the monthly IPI series because we seem us embedding 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 jump 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 coming from the statistics 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 the results of the both VAR's estimations and forecasts are illustrated. Finally there are some conclusive remarks and the appendix.

2. The economics of the yield curve

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 1980s. These analyses 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 predict the GDP growth accurately; on the other side, Mishkin's model derived from the Fisher condition (Mishkin 1990,1991) found that through the yield curve it's possible forecast the future inflation. These 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 both 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 impending recession (amongst the other Chu1993, Estrella, and Hardouvelis 1991, Estrella Mishkin1997, 1998). Subsequent researches investigate on whether the relationship between yield spread and future economic growth holds in countries other than the United States and they find that the term structure predicts the output growth in several other countries, UK and Germany particularly (amongst the other, Plosser, and Rouwenhorst 1994, Davis, and Henry 1994, Davis, and 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 of the relationships over time and across countries (amongst the other, Chauvet, and Potter 2002, Li *et al.* 2003). Therefore, although the relationship is strong, there are some theoretical reasons indicating that she may not be 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 they are influenced by the monetary policy regime. However, the yield curve should have predictive power for inflation and output in the 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, 743). On the 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 compared with the models 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 in order to forecasting of the recession probabilities. Ang *et al.* (2006) propose a dynamic model that characterizes completely the expectations on the output growth correcting the unconstrained and endogeneity problems arising from the previous studies.

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 represented by 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 of the expectations on the inflation rate and on the 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 $\pi_t^{\,e}$:

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

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 due to the future inflation. Therefore, the role of the time structure of the 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 losses. This market risk should be embedded in the nominal yield as a *risk premium* component[20].

Therefore, since the term in brackets $[r_t^{\,r} \; \pi_t^{\,e}]$ is too small and it isn’t relevant for the analysis, a risk adjusted Fisher equation is

$$r_t = r_t^{\,r} + \pi_t^{\,e} + mrp_t \qquad (2)$$

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.

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

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

and so

[20] Generally longer is the maturity of a bond, greater is the time of uncertainty and so higher is the market risk.

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

that is, the difference between the nominal long-term rate and short-term rate 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[21]. Since long-term debt is less liquid and his price more volatile, the short-term yields are usually lower than long-term yields. Therefore 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 the steady growth[22]. 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.

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 economic expansion phase. The spread is obviously greater than the upper limit of the one showed in the 'normal shaped'[23].

The change from a positive to a negative economic growth phase 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 rates 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 the recession is probably for-coming or just acting.

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

We have determined the shape of the yield curve for the European Union (at 16 countries) on monthly basis in the years 1994-2009; she is represented by the difference between 10-year Euro Area Government Benchmark Bond yield and Euribor 3-month interest rate[24]. This curve with the line representing the European Central Bank (ECB) interest rate which has been plotted in Figure1[25].

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. The ECB interest rate increases and the slope of the curve goes down when there is a monetary tightening. 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)[26]. In Figure 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.

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

[22] 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 rates is in the range of [1.50 , 2.50] basis points.

[23] *See* Taylor (1998).

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

[25] The ECB interest rate is the reference when the European Central Bank is implementing the monetary policy.

[26] 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'.

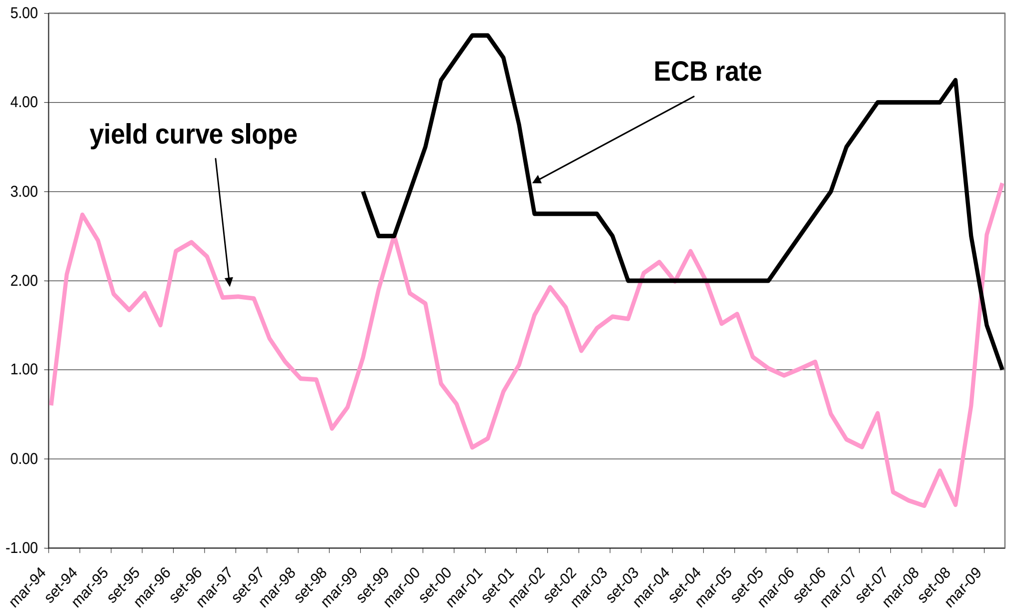


Figure 1. Yield Curve Slope and European Central Bank Interest Rate (ECB) (Euro Area)

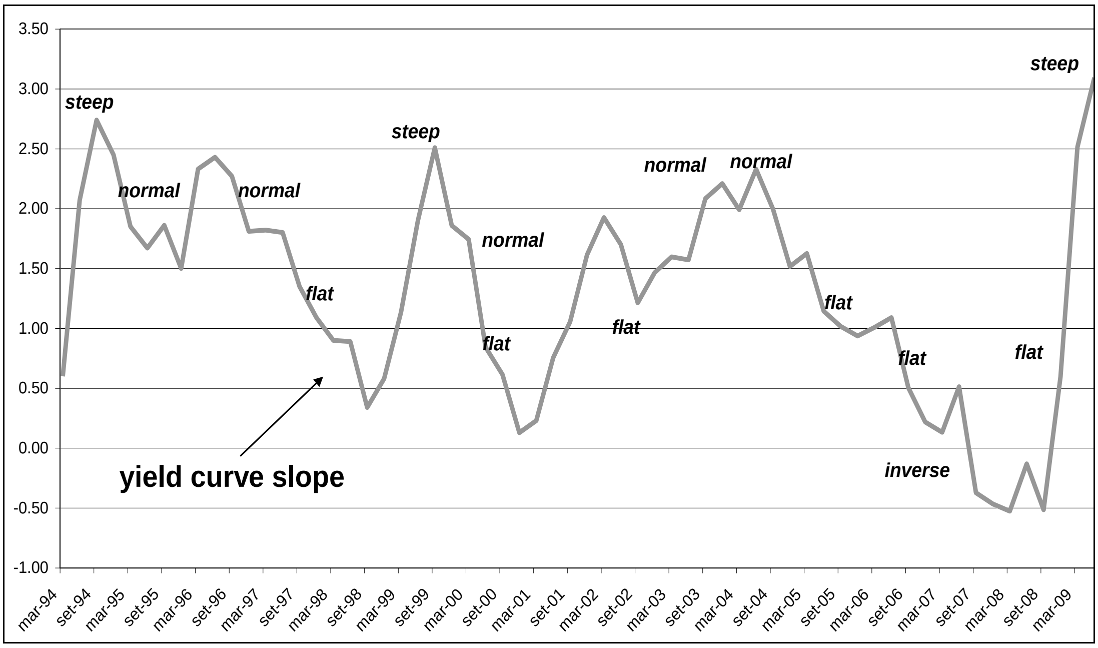


Figure 2. Yield Curve Slope reclassified (Euro Area)

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[27]. In the Figure 3 we have plotted the annual growth rate of GDP, the yield curve slope for the EMU and the ECB interest rate for the quarters 1994:Q1-2009:Q2. 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 monetary policy implementation[28].

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

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

[28] *See* Howard, 1989.

(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, that it's exhausted itself 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 %.

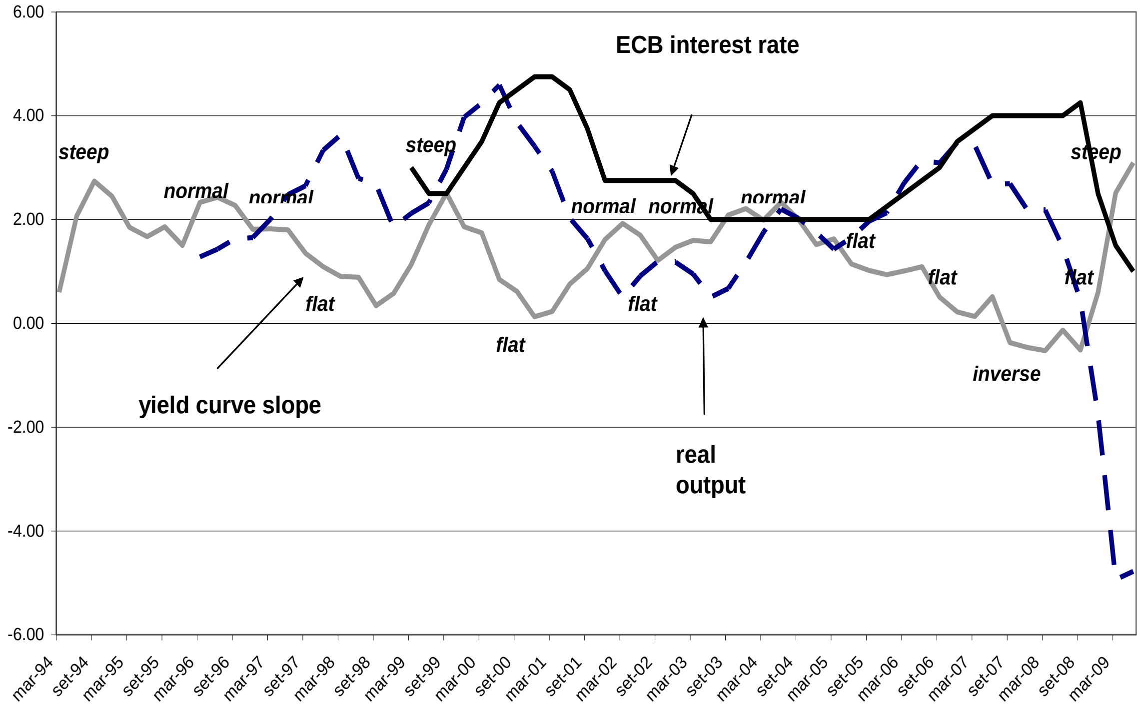


Figure 3. Yield Curve Slope and Business Cycle (Euro Area)

5. 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. Moreover, we propose an alternative approach to estimate a more extensive model (VAR2) and to forecast the output growth from it.

The large volatility of the short-term interest rates as much as the statistical restrictions suggest that both quarterly data and a monthly data must be consider in order to be able to catch the underlying dynamic of the yield curve. The estimates and the forecasts 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.

6. 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

$$SPREAD_t = GBBY10_t - EURIBOR3_t$$

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

$$OUTPUT_{GDP,t} = \Delta REAL\_GDP_t = \Delta_{t-4}\, GDP_t = \log(GDP_t) - \log(GDP_{t-4})$$

on quarterly basis, or

$$OUTPUT_{IPI,t} = \Delta_{t-12}\, IPI_t = \log(IPI_t) - \log(IPI_{t-12})$$

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 Figure 4 where there is plotted the $\Delta REAL\_GDP_t$ [Real output growth rate] and the $\Delta_{t-12}IPI_t$ [Industrial production growth rate] quarterly series for the period 1996:Q1-2009-Q2 (correlation and statistics are in Appendix, Tabb. A.I and A.II)[29].

Therefore in the first VAR model (VAR1) there are two endogenous variables ($i=1,2$) with two lags ($j=1,2$)

$$SPREAD_t = \beta_{1,t}\, SPREAD_{t-j} + \delta_{1,t}\, OUTPUT_{t-j} + \alpha_1 + \varepsilon_{1,t} \quad (5a)$$
$$OUTPUT_{i,t} = \beta_{2,t}\, SPREAD_{t-j} + \delta_{2,t}\, OUTPUT_{t-j} + \alpha_2 + \varepsilon_{2t} \quad (5b)$$

where $SPREAD_t$ is the difference between the long-term interest rate and the 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[30].

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

[30] The assumptions about the innovations are that they may be 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].

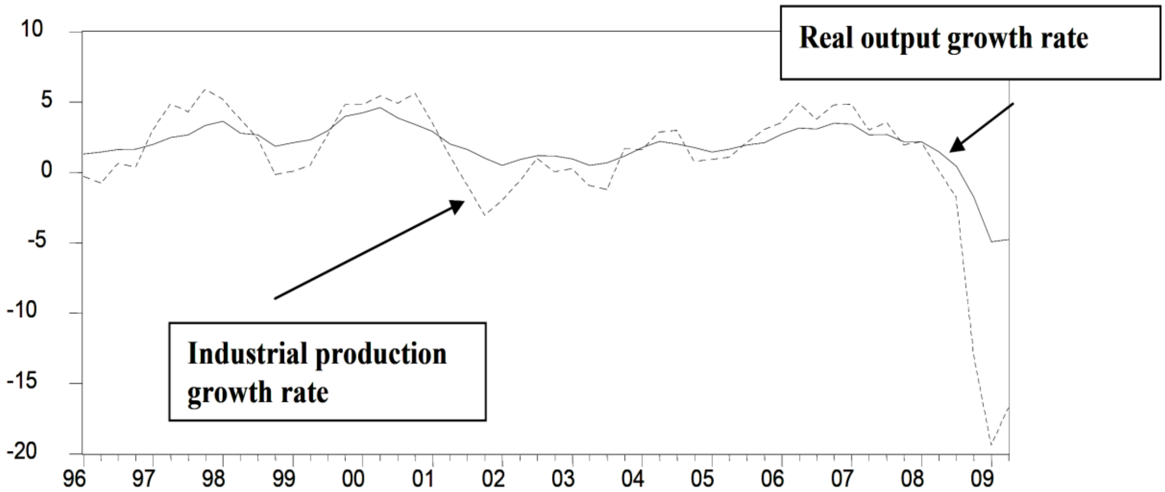


Figure 4. GDP versus IPI annual growth rate (Euro Area)

The estimation of VAR equations (5a) – (5b) with two lags GDP quarterly series for the period 1996:Q1-2008:Q4 confirms that the information embedded in the slope of the 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 (Figure 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* Appendix, Table A.III).

The VAR estimations in the model with six lags the $\Delta_{t-12}IPI_t$ monthly series confirm the results obtained on the quarterly ones (*see* Appendix – Table A.IV)[31]. The impulse response functions of this model are plotted in Figure 6.

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

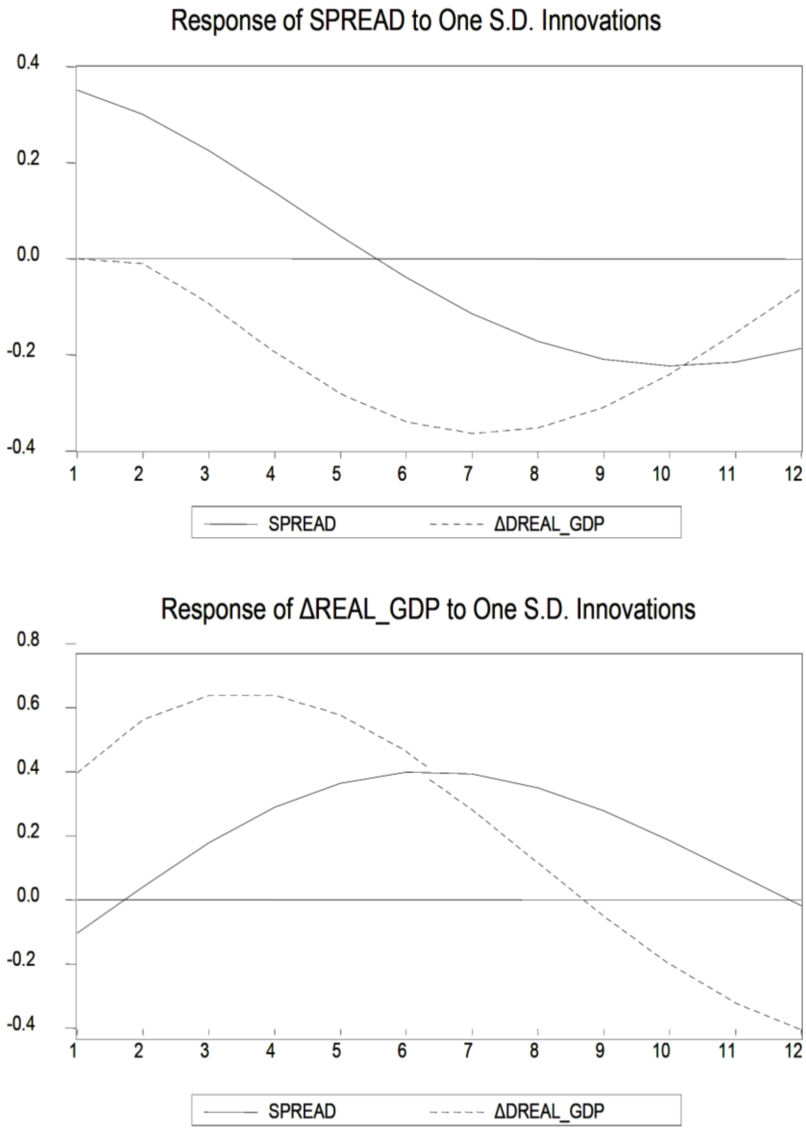


Figure 5. Impulse response functions for GDP in VAR1 Model (Euro Area)

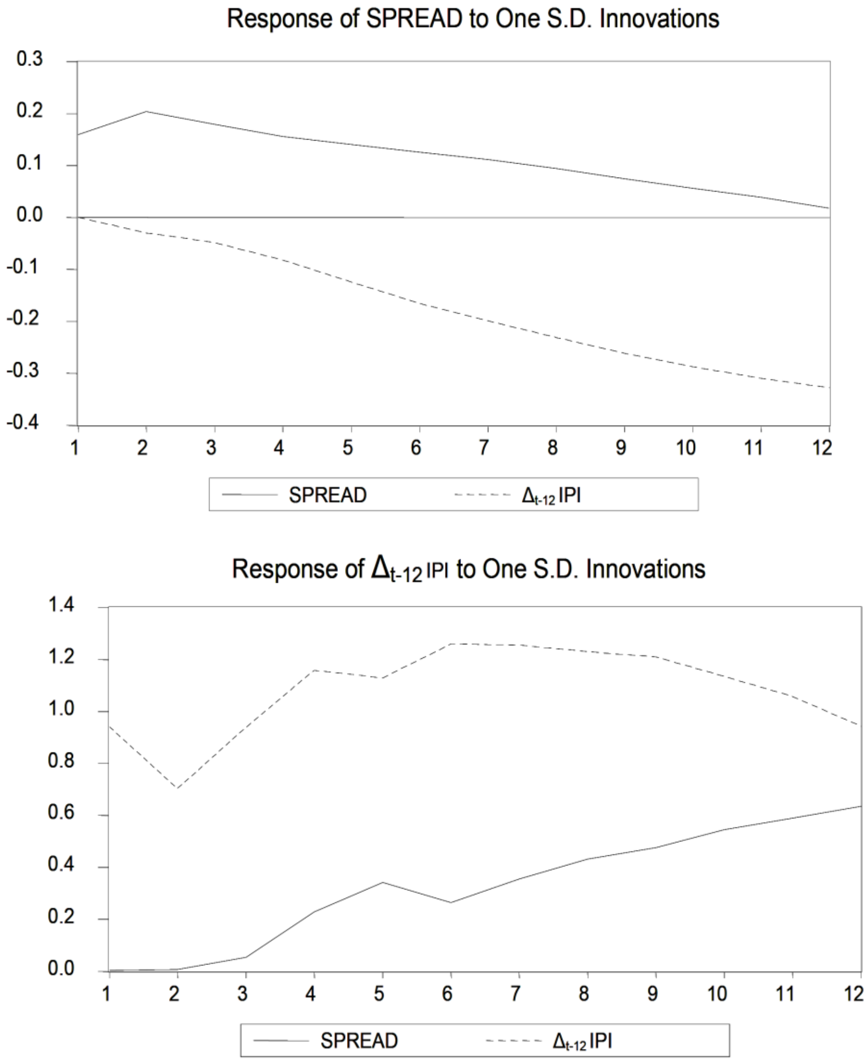
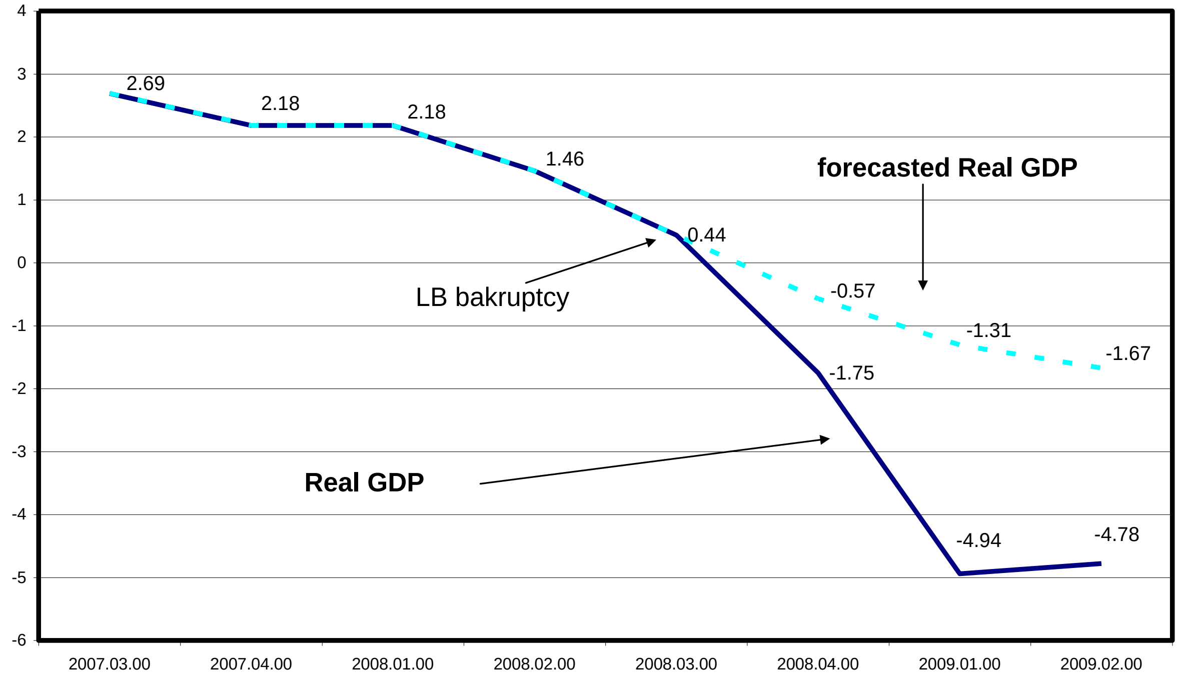
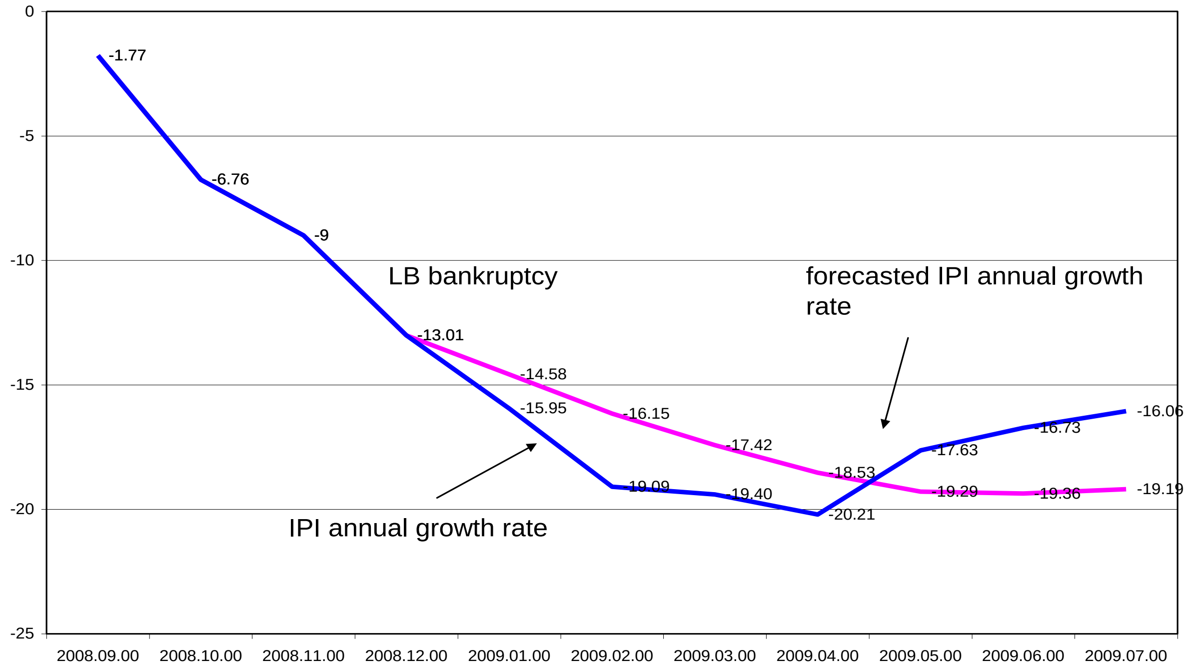


Figure 6. Impulse response functions for IPI in VAR1 Model (Euro Area)

Then, we provide an exercise of the out-of-sample forecast for quarterly $\Delta REAL\_GDP_t$ 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 Figure 7. In the upper side of Figure (7.1) there is the forecast of $\Delta REAL\_GDP_t$ series for the period 2008:Q4-2009:Q2; it shows that the estimated coefficients in equations (5b) takes into accounts the expectations of a thorough 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.



7.1. Quarterly GDP series



7.2. Monthly IPI series

Figure 7. Out-of-sample forecast according to VAR1 Model

7. 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.

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

(6a) – risk adjusted Fisher condition;
(6b) – risk adjusted Taylor Rule;
(6c) – risk adjusted Inflation Targeting Model;
(6d) – risk adjusted Output Gap Model;
(6e) – Arbitrage Pricing Theory Model[32];
(6f) – 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.

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

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

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

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

$$OUTPUT_t = \beta_{4,j}\, SPREAD_{t-j} + \eta_{4,j}\, SR_{t-j} + \kappa_{4,j}\, IR_{t-j} + \delta_{4,j}\, OUTPUT_{t-j} + \theta_{4,j}\, RETURN_{t-j} + \lambda_{4,j}\, BRP_{t-j} + \alpha_4 + \varepsilon_{4,t} \qquad (7e)$$

$$RETURN_t = \beta_{5,j}\, SPREAD_{t-j} + \eta_{5,j}\, SR_{t-j} + \kappa_{5,j}\, IR_{t-j} + \delta_{5,j}\, OUTPUT_{t-j} + \theta_{5,j}\, RETURN_{t-j} + \lambda_{5,j}\, BRP_{t-j} + \alpha_5 + \varepsilon_{5,t} \qquad (7f)$$

$$BRP_t = \beta_{6,j}\, SPREAD_{t-j} + \eta_{6,j}\, SR_{t-j} + \kappa_{6,j}\, IR_{t-j} + \delta_{6,j}\, OUTPUT_{t-j} + \theta_{6,j}\, RETURN_{t-j} + \lambda_{6,j}\, BRP_{t-j} + \alpha_6 + \varepsilon_{6,t} \qquad (7g)$$

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 identified empirically by *VOLATILITY* variable[33]. We assume as a proxy of the inflation innovation in the equations (7a) – (7f) 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.

[32] Ross, 1976.

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

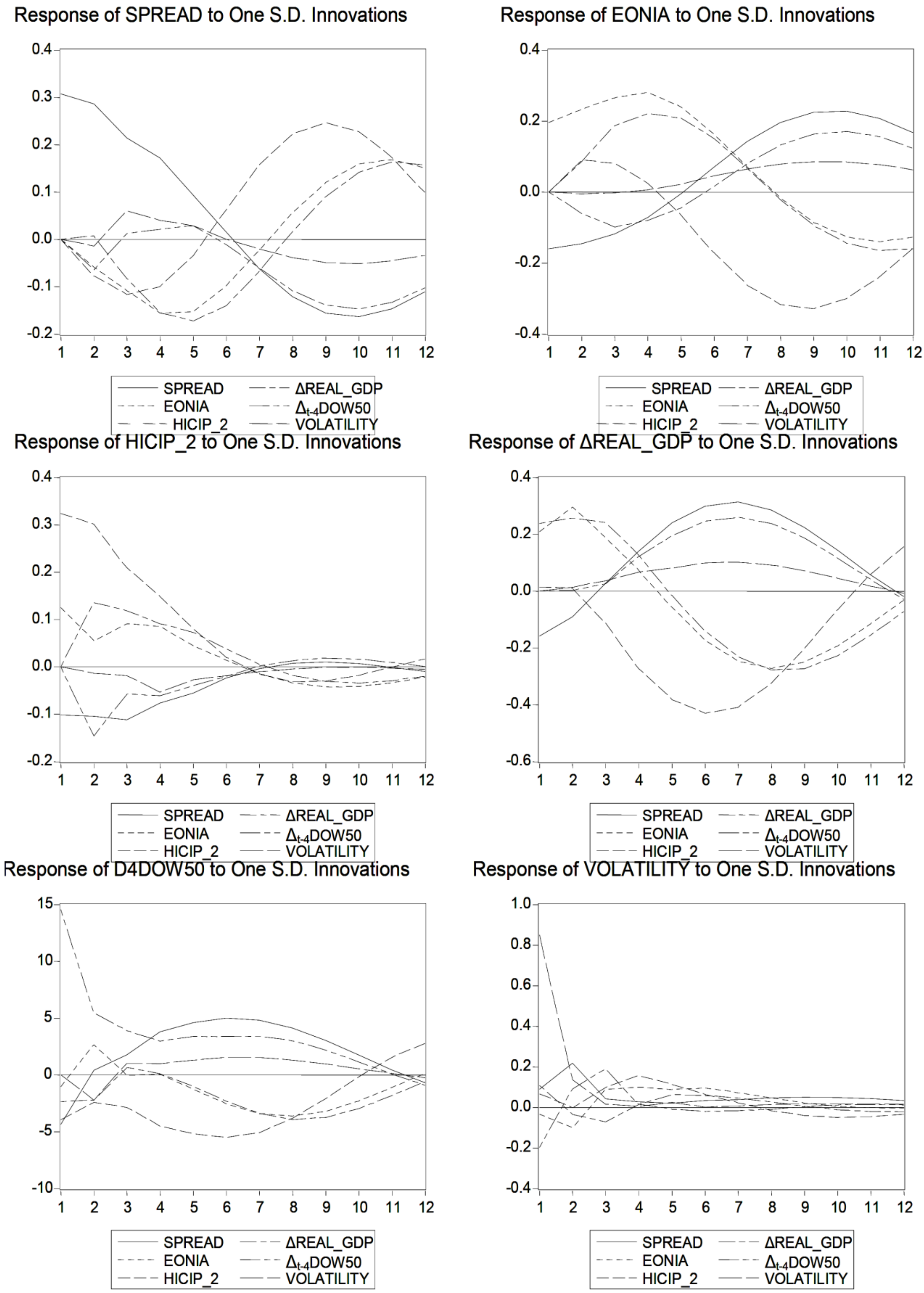


Figure 8. Impulse response functions for GDP in VAR2 Model

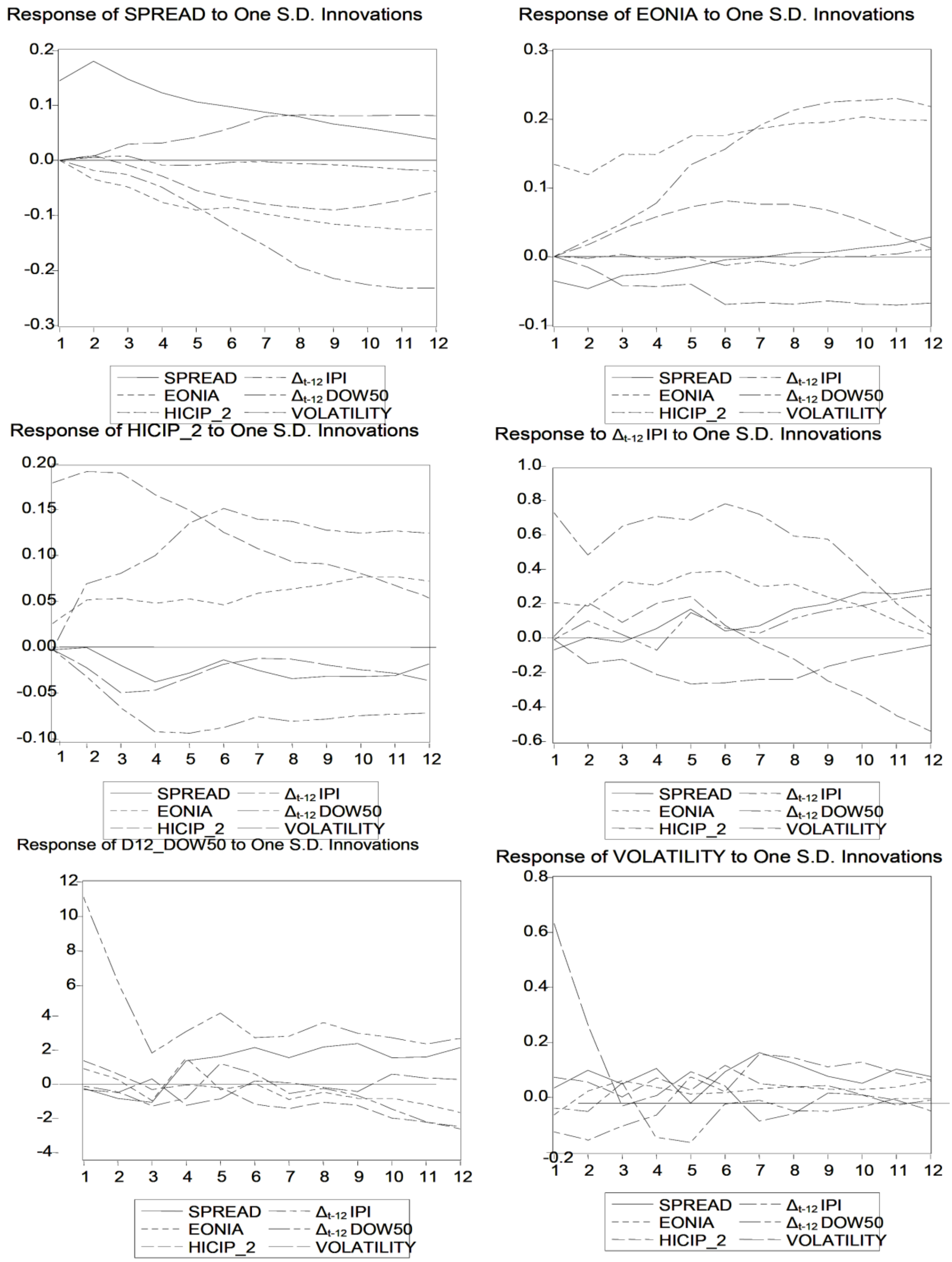


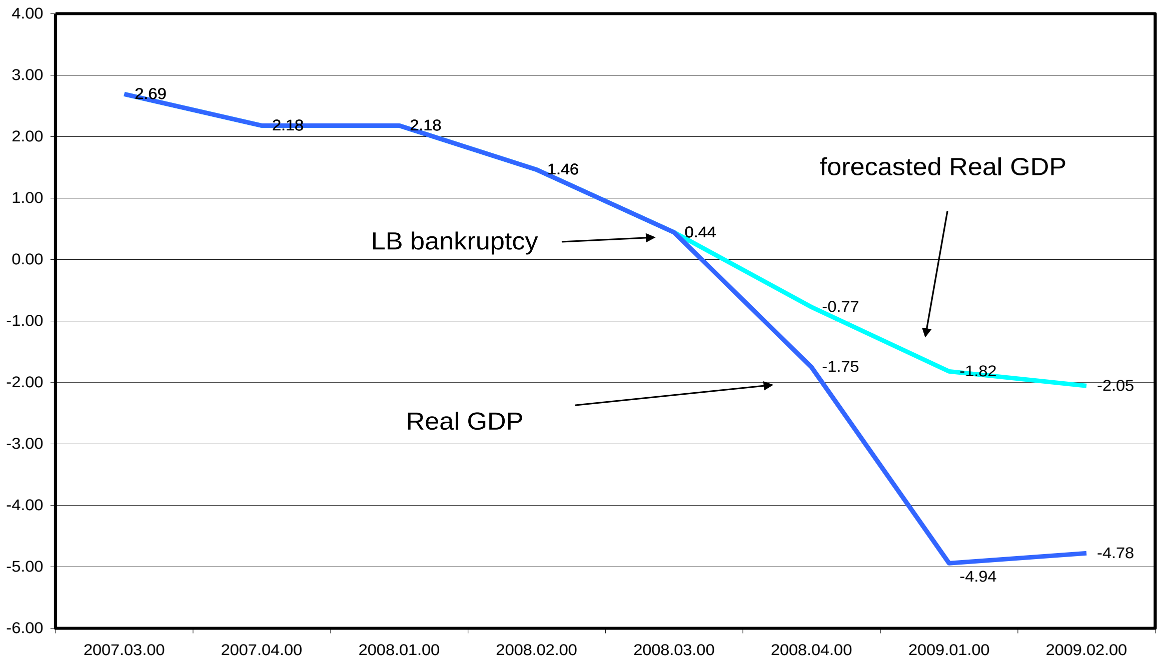
Figure 9. Impulse response functions for IPI in VAR2 Model

The statistics on the estimated coefficients of the VAR2 model for the $\Delta REAL\_GDP_t$ quarterly series are reported in Appendix (*see* the Table A.V)[34]. In particular, it can see that the coefficients of the equation (7d) are statistical significant and have predicted sign. The estimation of the coefficients of equations (7a) – (7f) on monthly $\Delta_{t-12}IPI_t$ series are less performing than the coefficients of the quarterly series. Both the six lag VAR estimations of the quarterly GDP series and of the monthly IPI series are convergent (*see* Appendix, Table A.VI)[35]. The impulse response functions of both the models are plotted in Figures 8 and 9, respectively, and confirm the previous conclusions. This enable us to present in Figure 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 provide results more performing than the previous exercise.

8. Concluding remarks

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

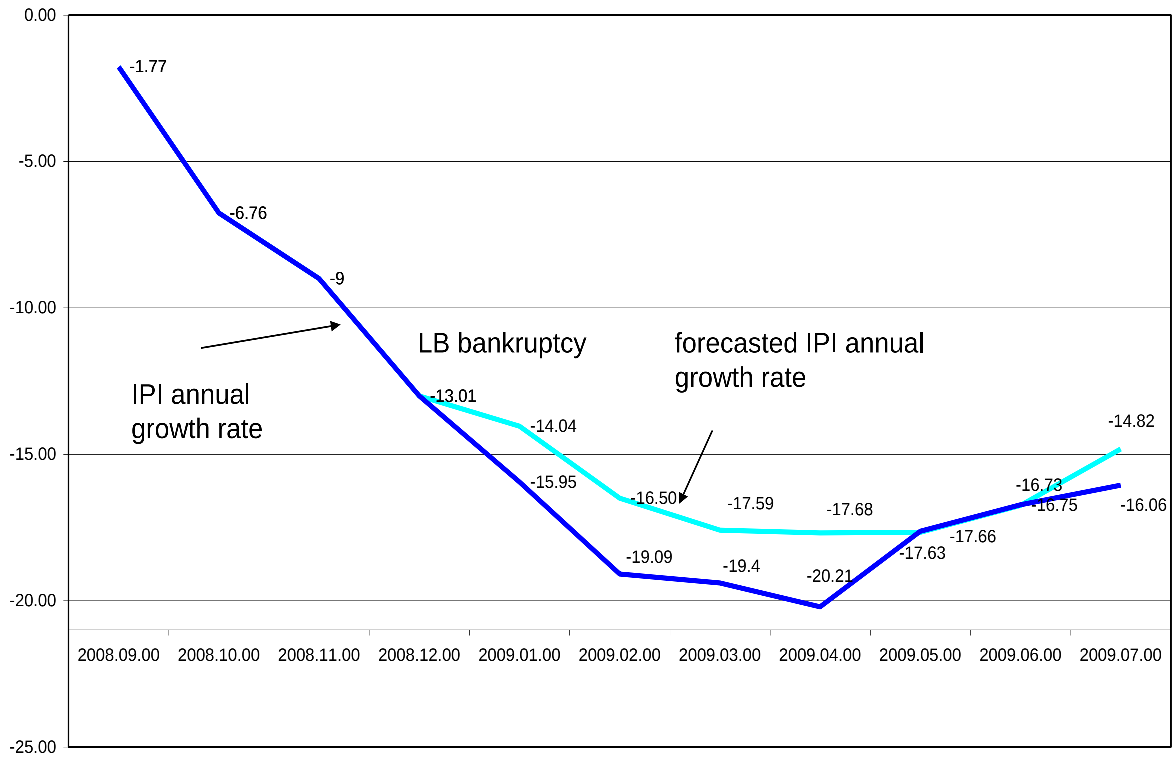
We produce the VAR estimations and the out-of-sample forecasts both for the Gross Domestic Product (GDP) quarterly series and for Industrial Production Index (IPI) monthly series of the EU (at 16 countries). The estimates confirm the robustness of the positive relationship between the monthly changes 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 and the short-term interest rates is persistent on the IPI growth rate from the 8th month and on the GDP growth rate from the 3th quarter. The quarterly estimates are significant while the monthly estimates 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.



10.1. Quarterly GDP Series

[34] 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.

[35] However the standard errors of each coefficient of the equations (5a) – (5b) on monthly series are larger than the quarterly estimated ones.



10.2. Monthly IPI Series

Figure 10. Out-of-sample forecast according to VAR2 Model

References

[1] Ang, A., Piazzesi, M., and Wei, M. 2006. What does the Yield Curve tell us about GDP growth?, *Journal of Econometrics*, 131: 359–403.

[2] Burmeister, E., and Wall, K.D. 1986. The Arbitrage Pricing Theory and Macroeconomic Factor Measures, *The Financial Review,* 21:1-20.

[3] Canova, F., and De Nicolo, G. (2000) – 'Stock Returns, Term Structure, Inflation and Real Activity: an International Perspective', *Macroeconomic Dynamics*, 4:343-372;

[4] Chauvet, M., and Potter, S. 2005. Forecasting Recession Using the Yield Curve, *Journal of Forecasting*, 24:77-103;

[5] Chu, Z. 1993. The Yield Curve and Real Activity, *IMF Staff Papers*, 40:781-806;

[6] Clarida, R., Gertler, M. and Galí, J. 1998. Monetary Policy Rules in Practice: Some International Evidence, *European Economic Review*, 42 (6):1033-67.

[7] Clarida, R., Gertler, M. and Galí, J. 2000. Monetary Policy Rules and Macroeconomic Stability: Theory and Some Evidence, *Quarterly Journal of Economics*, 115:147-180.

[8] Davis, E.P., and Henry, S.G.B. 1994. The Use of Financial Spreads as Indicator Variables: Evidence for the United Kingdom and Germany, *IMF Staff Papers*, 41: 517-525;

[9] Davis, E.P., and Fagan, F. 1997. Are Financial Spreads Useful Indicators of Future Inflation and Output Growth in EU Countries?, *Journal of Applied Econometrics*, 12: 701-714;

[10] Duarte, A., Venetis, I.A., and Paya, I. 2005. Predicting Real Growth and the Probability of Recession in the Euro Area Using the Yield Spread, *International Journal of Forecasting*, 21: 261-277;

[11] Estrella, A., and Hardouvelis, G.A. 1991. The Term Structure as a Predictor of Real Economic Activity, *Journal of Finance*, 46: 555-576;

[12] Estrella, A., and Mishkin, F.S. 1997. The Term Structure of Interest Rates and Its Role in Monetary Policy for the European Central Bank, *European Economic Review*, 41:1375-1401

[13] Estrella, A., and Mishkin, F.S. 1998. Predicting U.S. Recessions: Financial Variables as Leading Indicators, *Review of Economics and Statistics*, 80: 45-61;

[14] Estrella, A., Rodrigues, A.P., and Schich, S. 2003. How STable is the Predictive Power of the Yield Curve? Evidence from Germany and the United States, *The Review of Economics and Statistics*, 85: 629-644;

[15] Favero, C.A., Kaminska, I., and Sodeberg I. 2005. The Predictive Power of the Yield Spread: Further Evidence and a Structural Interpretation, *CEPR Discussion Paper N. 4910*;

[16] Funke, N. 1997. Yield Spreads as Predictor of Recessions in a Core European Economic Area, *Applied Economics Letters*, 4: 695-697;

[17] Gertler, M., and Lown, C.S. 2000. The Information in the High Yield Bond Spread for the Business Cycle. Evidence and Some Implications, *NBER Working Paper N. 7549*;

[18] Hamilton, J.D., and Dong, H.K. 2002. A Re-examination of the Predictability of Economic Activity Using the Yield Spread, *Journal of Money, Credit and Banking*, 34: 340-360;

[19] Harvey, C.R. 1988. The Real Term Structure and Consumption Growth, *Journal of Financial Economics*, 22:305-333;

[20] Harvey, C.R. 1993. Term Structure Forecasts Economic Growth, *Financial Analyst Journal*, 49(3): 6-8;

[21] Howard, K. 1989. The yield curve as a predictor of the business cycle, *Business Economics*, October;

[22] Haubrich, J.G., and Dombrosky, A. 1996. Predicting Real Growth Using the Yield Curve, *Economic Review*, 32:26-35;

[23] Ilmanen, A., and Iwanowski, R., 1997. Dynamics of the Shape of the Yield Curve, *The Journal of Fixed Income*, 7(2):47-60;

[24] Ivanova, D., Lahiri, K., and Seitz, F. 2000. Interest Rate Spreads as Predictor of German Inflation and Business Cycles, *International Journal of Forecasting*, 16: 39-58;

[25] Li, N., Ayling, D.E., and Hodgkinson, L. 2003. An Examination of the Information Role of the Yield Spread and Stock Returns for Predicting Future GDP, *Applied Financial Economics*, 13:593-597;

[26] McMillan, D.G. 2002. Interest Rate Spread and Real Activity: Evidence for the UK, *Applied Economic Letters*, 9:191-194;

[27] Mishkin, F.S. 1990. What Does the Term Structure tell us about Future Inflation?, *Journal of Monetary Economics*, 25:77-95;

[28] Mishkin, F.S. 1991. A Multi-Country Study of the Information in the Shorter Maturity Term Structure about Future Inflation, *Journal of International Money and Finance*, 10:2-22;

[29] Moneta, F. 2003. Does the Yield Spread Predict Recessions in the Euro Area, *European Central Bank Working Paper N. 294*;

[30] Peel, D., and Taylor, M. 1998. The Slope of the Yield Curve and Real Economic Activity: Tracing the Transmission Mechanism, *Economics Letters*, 59: 353-360;

[31] Plosser, C.I., and Rouwenhorst, K.G. 1994. International Term Structures and Real Economic Growth, *Journal of Monetary Economics*, 33:133-155;

[32] Roll, R., and Ross, S. 1980. An Empirical Investigation of the Arbitrage Pricing Theory, *Journal of Finance* 35(4): 1073-1103.

[33] Roma, A., and Torous, W. 1997. The Cyclical Behavior of Interest Rates, *Journal of Finance*, 52: 1519-1542;

[34] Ross, S. 1976. The Arbitrage Theory of Capital Pricing, *Journal of Economic Theory,* 13:341-360;

[35] Tashman, L.J. 2000. Out-of-sample Tests of the Term Structure of Forecast Accuracy: an Analysis and Review, *International Journal of Forecasting*, 16:437-450;

[36] Taylor, J.B. 1993. Discretion versus Policy Rules in Practice, *Carnegie-Rochester Conference Series on Public Policy*, 39:195-214;

[37] Taylor, J.B. 1998. *Investment timing and the business cycle*, John Wiley & Sons Inc., Canada;

[38] Taylor, J.B. 1999. *Monetary Policy Rules*, Chicago: Chicago University Press;

[39] Watkins, T. 2008. Irving Fisher's Theory of Interest Rates With and Without Adjustment for Tax Rates and Risk Premiums, *MIMEO, San José State University Economic Department*.

APPENDIX

Table A.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

Table A.II. Correlation and statistics of $\Delta_{t-12} IPI_t$ and Δ *REAL_GDP* (Euro Area)

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

Table A.III. Estimated VAR1 model (5a) – (5b), 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 (0.14985) (5.66889)	0.533289 (0.17471) (3.05247)
SPREAD(-2)	-0.137119 (0.15548) (-0.88192)	-0.224990 (0.18127) (-1.24115)
ΔREAL_GDP(-1)	-0.026141 (0.13497) (-0.19368)	1.418446 (0.15736) (9.01407)
C	0.752772 (0.20803) (3.61859)	-0.465340 (0.24254) (-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 A.IV. Estimated VAR1 model (5a) – (5b), 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 (0.08166) (15.6726)	0.031590 (0.48179) (0.06557)
SPREAD(-2)	-0.512008 (0.13231) (-3.86981)	0.255649 (0.78058) (0.32751)
SPREAD(-3)	0.204487 (0.13843) (1.47718)	0.800375 (0.81670) (0.98001)
SPREAD(-4)	-0.014183 (0.13231) (-0.10720)	-0.422760 (0.78057) (-0.54161)
SPREAD(-5)	0.002319 (0.12503) (0.01855)	-1.265008 (0.73764) (-1.71493)
SPREAD(-6)	0.007851 (0.07989) (0.09828)	0.958435 (0.47132) (2.03349)
Δ_{t-12} IPI(-1)	-0.032055 (0.01411) (-2.27099)	0.747547 (0.08327) (8.97703)
Δ_{t-12} IPI(-2)	0.013275 (0.01766) (0.75152)	0.439016 (0.10421) (4.21282)
Δ_{t-12} IPI(-3)	-0.015684 (0.01816) (-0.86376)	0.166935 (0.10712) (1.55834)
Δ_{t-12} IPI(-4)	-0.002114 (0.01867)	-0.241149 (0.11012)

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

Table A.V. Estimated VAR2 Model (7a) – (7f), 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)

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(-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)	(1.89604)	(-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)

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
	(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				

Table A.VI. Estimated VAR2 Model (7a) – (7f), 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	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	1.179193	-0.104556	0.074214	0.424248	-3.875682	0.667265
SPREAD(-1)	(0.09138)	(0.08752)	(0.11623)	(0.48991)	(7.14184)	(0.41299)
	(12.9041)	(-1.19471)	(0.63853)	(0.86596)	(-0.54267)	(1.61570)
	-0.484393	0.280744	-0.238985	-0.137729	0.206907	-0.535581
SPREAD(-2)	(0.14034)	(0.13440)	(0.17849)	(0.75237)	(10.9678)	(0.63423)
	(-3.45167)	(2.08888)	(-1.33893)	(-0.18306)	(0.01886)	(-0.84445)
	0.221756	-0.155683	0.072234	0.684432	20.50495	0.867317
SPREAD(-3)	(0.14964)	(0.14331)	(0.19032)	(0.80223)	(11.6947)	(0.67627)
	(1.48197)	(-1.08636)	(0.37954)	(0.85316)	(1.75335)	(1.28251)
	-0.073876	0.112746	0.141840	0.002937	-12.90291	-1.348473
SPREAD(-4)	(0.14698)	(0.14077)	(0.18695)	(0.78801)	(11.4874)	(0.66428)
	(-0.50261)	(0.80094)	(0.75873)	(0.00373)	(-1.12322)	(-2.02998)
	0.103461	-0.071072	-0.073364	-1.399680	9.210657	1.477910
SPREAD(-5)	(0.13838)	(0.13252)	(0.17600)	(0.74186)	(10.8147)	(0.62538)
	(0.74768)	(-0.53630)	(-0.41685)	(-1.88671)	(0.85168)	(2.36323)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
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)

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	(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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-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)
ΔT-12 DOW50(-5)	0.000592	-0.002146	-0.002008	-0.008623	-0.031764	0.001913

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
	(0.00138)	(0.00132)	(0.00176)	(0.00742)	(0.10812)	(0.00625)
	(0.42824)	(-1.61983)	(-1.14130)	(-1.16262)	(-0.29378)	(0.30592)
	-0.001063	0.001345	0.001909	-0.001778	0.088974	0.004472
ΔT-12 DOW50(-6)	(0.00121)	(0.00116)	(0.00154)	(0.00648)	(0.09443)	(0.00546)
	(-0.87998)	(1.16250)	(1.24248)	(-0.27455)	(0.94224)	(0.81902)
	0.012065	-0.023985	-0.031454	-0.222853	-0.298344	0.419850
VOLATILITY(-1)	(0.01927)	(0.01845)	(0.02451)	(0.10330)	(1.50584)	(0.08708)
	(0.62619)	(-1.29983)	(-1.28354)	(-2.15739)	(-0.19812)	(4.82155)
	0.017762	-0.025767	-0.007715	0.082841	1.223028	-0.247311
VOLATILITY(-2)	(0.01859)	(0.01780)	(0.02364)	(0.09966)	(1.45278)	(0.08401)
	(0.95551)	(-1.44741)	(-0.32634)	(0.83126)	(0.84185)	(-2.94386)
	-0.017932	0.015706	0.014739	-0.136669	-2.826182	0.132338
VOLATILITY(-3)	(0.01903	(0.01822)	(0.02420)	(0.10200)	(1.48697)	(0.08599)
	(-0.94247)	(0.86196)	(0.60906)	(-1.33985)	(-1.90063)	(1.53905)
	0.017628	0.010321	0.025677	-0.003655	1.373316	0.057664
VOLATILITY(-4)	(0.01937)	(0.01855)	(0.02463	(0.10383)	(1.51365)	(0.08753)
	(0.91021)	(0.55642)	(1.04238)	(-0.03520)	(0.90729)	(0.65879)
	0.002462	-0.022383	0.019163	-0.029027	0.186125	0.015186
VOLATILITY(-5)	(0.01888)	(0.01808)	(0.02401)	(0.10120)	(1.47525)	(0.08531)
	(0.13040)	(-1.23817)	(0.79819)	(-0.28683)	(0.12617)	(0.17802)
	0.010620	0.016710	0.005797	-0.020280	-0.274649	-0.165381
VOLATILITY(-6)	(0.01777)	(0.01702)	(0.02261)	(0.09529)	(1.38905)	(0.08032)
	(0.59755)	(0.98169)	(0.25646)	(-0.21283)	(-0.19772)	(-2.05892)
	0.000234	0.101079	-0.103911	0.714884	-3.260020	2.002962
C	(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

Sample(adjusted): 1995:07 2008:12 Included observations: 162 after adjusting endpoints Standard errors & t-statistics in parentheses						
	SPREAD	EONIA	HICIP-2	ΔT-12 IPI	ΔT-12 OW50	VOLATILITY
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				

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