Economics Bulletin

Volume 30, Issue 1

The relationship between changes in the Economic Sentiment Indicator and real GDP growth: a time-varying coefficient approach

Luca Zanin
Prometeia

Abstract

The aim of this paper is to capture the time-varying effects of the relationship between changes in the Economic Sentiment Indicator (ESI) and economic growth. We use penalized regression splines to estimate the different point effects over time. Evidence from six European countries supports the idea that the elasticity of the ESI is time-varying.

I would like to thank Giampiero Marra and Massimo Guagnini for many detailed suggestions on the earlier draft of this paper, and Zhijie Xiao (Associate Editor) and one anonymous reviewer for helpful comments that have improved the presentation of the article. I remain solely responsible for any errors.

Citation: Luca Zanin, (2010) "The relationship between changes in the Economic Sentiment Indicator and real GDP growth: a time-varying coefficient approach", *Economics Bulletin*, Vol. 30 no.1 pp. 837-846.

Submitted: Oct 18 2009. **Published:** March 25, 2010.

1 Introduction

In the late '40s, George Katona and his colleagues from the Survey Research Center at the University of Michigan conducted the first surveys on consumer attitudes and expectations. In 1952, an Index of Consumer Sentiment for the U.S. was constructed and since 1955 it has been published at regular intervals. These surveys have been the foundation for the investigation and deepening of some themes of psychological economics in consumer behavior as well as business firms' behaviors (Katona, 1951, 1977). Over the years, in many countries, these indicators have acquired relevant interest from economic operators, the media and government officials. Some economists have investigated the relationship between consumer sentiment and consumer spending (see Carroll *et al.*, 1994; Bram and Ludvigson, 1998; and Ludvigson, 2004). Using U.S. data, they found that consumer sentiment can help to predict consumer expenditures, but there have not been unanimous results achieved regarding the role of leading indicator. In a recent article, Qiao *et al.* (2009), applying a linear and non-linear Granger causality test, have found that the Michigan Index is useful in predicting the consumption dynamics of the U.S. In addition, Westerhoff (2008), with an approach to the Neimark-Sacker bifurcation scenario, showed that consumer sentiment may influence economic activity.

In European countries, the confidence indicators of the consumers (households) and of the sectors of industry, construction, retail trade and services are constructed through a selected number of questions detected using five separate surveys conducted at national level and on monthly basis. To ensure the best comparison of the indicators among countries, the European commission adopted a joint harmonization programme (European Commission, 2007). In order to track the overall economic activity, all five confidence indicators above are summarized in an Economic Sentiment Indicator, with weights determined pragmatically (Industry 40%; Construction 5%; Retail Trade 5%; Services 30%; Consumers 20%) after a prior process of standardization (European Commission, 2007). Studies that take into account the relationship between the ESI and some macroeconomic variables show the different predictive power of the indicator (Cotsomitis and Kwan, 2006; Gelper and Croux, 2007, 2010). The aim of this article is to use classic linear regression modelling and a time-varying coefficient approach to explain the relationship between changes in the ESI and real Gross Domestic Product (GDP) growth. The remainder of the article is organized as follows: Section 2 briefly describes the data and Section 3 presents the specification of the econometric models. Section 4 shows the main empirical results and Section 5 provides some conclusions.

2 Data

Data for the real GDP and the ESI are provided by the Eurostat and European Commission databases. The ESI data are available on a monthly basis. We convert them into quarterly-frequency data calculating the average of the monthly observations for each quarter. The sample periods considered in this article are: 1985:I - 2008:IV for Finland, France and Italy; 1990:I - 2008:IV for Denmark and Austria; and 1995:I - 2008:IV for

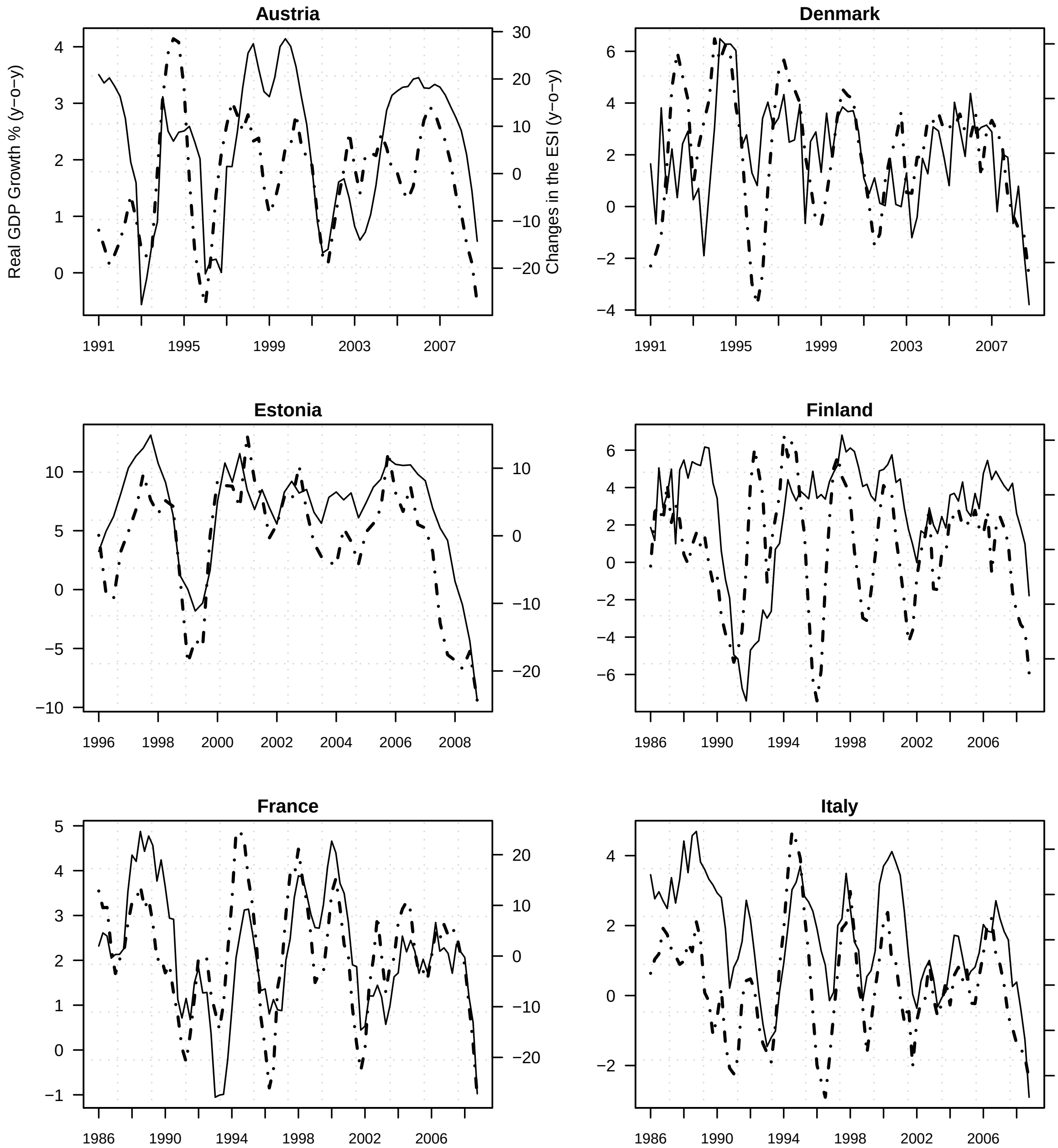

Figure 1: Real GDP growth is represented by a solid line; the Economic Sentiment Indicator is represented by a dotdashed line.

Estonia. All data are seasonally adjusted (SA). The countries above cover several types of economies that can be classified as follows: Major advanced economies in the Euro area (France and Italy), advanced economies in the Euro area (Austria and Finland), European advanced economies (Denmark), and European emerging and developing economies (Estonia). Figure 1 shows the time series of real GDP growth in percentage terms (year-on-year), and the change in the ESI (year-on-year) for six European countries. In all graphs we can notice the magnitude of the economic slowdown that characterizes the last quarters of the time series. The causes of the slowdown may be found in the global financial crisis and of the real estate sector, the presence of a high level of inflation in many countries, which has been influenced by high prices of commodities, and so on. All of these factors, though not exhaustive, have contributed also to a gradual and general deterioration in the confidence of consumers and businesses. A low confidence in the context of economic uncertainty has a negative effect in the spending behavior of consumers, which tend to lend more attention in their purchasing as a form of precaution. As an example, in these contexts it is not new to observe a reduction of the willingness to buy goods not strictly necessary as a car, a dwelling, but also clothing, furniture, electronic goods, etc. As a consequence, business confidence suffers from the increase of the stock of finished product, the low level of order books and the decrease in profits and sales. It is also natural to observe an increase in competitiveness among firms through a mix of marketing strategies (e.g. discount packages, promotions for limited periods, etc. (see also the study of Ginsburgh and Zang, 2007) to incentive the sales. The government and its economic and fiscal policies play an important role in restoring confidence among operators (consumers and businesses) so that the nation can return to an expansive economic cycle. In summary, the structure of the ESI should be a good composite quali-quantitative measure to monitor over time the magnitude of the negative as well as the positive confidence of consumers and businesses in the whole.

3 The models

The empirical analysis considers two models. The first is based on a simple linear regression and the second specifies an additive model (AM) with the coefficient of the ESI expressed in a time-varying structure. The first model, which can be estimated using ordinary least squares (OLS), takes the following form:

$$(\Delta^4 y_t/y_{t-4})_t = \beta_0 + \beta_1(\Delta^4 ESI)_t + \sum_{i=1}^{m} \phi_i(\Delta^4 y_t/y_{t-4})_{t-i} + \epsilon_t, \tag{1}$$

where Δ^4 denotes difference operator of order 4 (e.g. $\Delta^4 x_t = x_t - x_{t-4}$), y is the real GDP growth and ESI is the Economic Sentiment Indicator. The use of Δ^4 allows us to capture changes from year to year. β_0 is the intercept, β_1 is the parameter of ESI, the ϕ_i represent the m autoregressive parameters of the dependent variable and ϵ_t with mean 0 and variance σ^2.

In order to investigate a possible change in the ESI elasticity over time, we employ a time-varying coefficient model (Hastie and Tibshirani, 1993), where (1) becomes:

$$(\Delta^4 y_t / y_{t-4})_t = \beta_0 + s(t)(\Delta^4 ESI)_t + \sum_{i=1}^{m} f_i(\Delta^4 y_t / y_{t-4})_{t-i} + \epsilon_t, \quad (2)$$

$\mathbf{s}(\mathbf{t})$ is an unknown smooth function that models the ESI effects for different points in time, $\boldsymbol{\beta} = (\beta_1, \beta_2, \ldots, \beta_T)_{T\times 1}$. The f_i represent instead the smooth functions of the autoregressive terms, which allow us to fully explain the autoregressive structure present in the data. The smooth terms in model (2) can be represented using regression splines. For instance,

$$s(t) = \mathbf{B}(t)\boldsymbol{\alpha}$$

where $\mathbf{B}(\mathbf{t})$ is the model matrix containing the spline basis for $s(t)$ and $\boldsymbol{\alpha}$ is the corresponding regression parameter vector. Here, we use thin plate regression splines (Wood, 2003, 2006) with 10 basis functions to ensure good flexibility in the estimatation of model (2). This spline basis has good mathematical proprieties and numerical stability. The use of a spline model may result in over-fitting. For this reason, we adopt a penalized spline approach. Specifically, during the model fitting process we use a quadratic penalty such as $\sum_j \lambda_j \boldsymbol{\beta}^{\mathsf{T}} \mathbf{S}_j \boldsymbol{\beta}$, and minimize

$$\|\mathbf{y} - \mathbf{X}\boldsymbol{\beta}\|^2 + \sum_j \lambda_j \boldsymbol{\beta}^{\mathsf{T}} \mathbf{S}_j \boldsymbol{\beta}, \quad \text{w.r.t.} \quad \boldsymbol{\beta},$$

where $\mathbf{X}$ contains the spline bases of all smooth terms in the model, with corresponding parameter vector $\boldsymbol{\beta}$, and the λ_j are smoothing parameters, controlling the trade-off between model fit and model smoothness. These are estimated by minimizing the generalized cross validation (GCV) score via the computational method of Wood (2006). The smoothing parameters play an important role since a small value for the generic λ_j reduces the bias of the fit but increases the variance, and vice versa. The $\mathbf{S}_j$ are matrices of known coefficients whose values depend on the order of the derivatives chosen to represent the roughness of the smooth terms. The order is usually set to 2, but as illustrated in the next section it can be set to 3 to capture weak non-linear signals of the economic relationship under study. Testing the hypothesis, $H_0 : \boldsymbol{\beta}_j = \mathbf{0}$ can tell the researcher whether the estimated coefficients of the j^{th} smooth component are time-varying. P-value calculations can be based on the approximate result (Wood, 2006):

$$\widehat{\boldsymbol{\beta}}_j^{\mathsf{T}} \widehat{\mathbf{V}}_{\widehat{\boldsymbol{\beta}}_j}^{r-} \widehat{\boldsymbol{\beta}}_j / r \backsim F_{r, n-\text{edf}},$$

where $\widehat{\boldsymbol{\beta}}_j$ contains the coefficients for a single smooth term, $\mathbf{V}_{\widehat{\boldsymbol{\beta}}_j}$ is the covariance matrix of $\widehat{\boldsymbol{\beta}}_j$, r is the rank of $\mathbf{V}_{\widehat{\boldsymbol{\beta}}_j}$, $\mathbf{V}_{\widehat{\boldsymbol{\beta}}_j}^{r-}$ is the rank r pseudoinverse of $\mathbf{V}_{\widehat{\boldsymbol{\beta}}_j}$, and *edf* represents the effective degrees of freedom of the penalized model.

4 Empirical results

We started by modeling the relationship between changes in the ESI and real GDP growth in a linear structure using the OLS method. Table 1 shows the results from model (1).

Coefficients	Austria	Denmark	Estonia	Finland	France	Italy
Intercept	0.50	1.12	2.22	0.16	0.45	0.32
	(0.00)	(0.00)	(0.00)	(0.33)	(0.00)	(0.00)
$\phi_1(\Delta^4 y_t/y_{t-4})_{t-1}$	0.92	0.41	0.96	0.63	0.77	0.77
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\phi_2(\Delta^4 y_t/y_{t-4})_{t-2}$	-	-	-0.29	0.30	-	-
			(0.00)	(0.00)		
$\phi_3(\Delta^4 y_t/y_{t-4})_{t-3}$	-0.15	-	-	-	-	-
	(0.09)					
$\beta_1(\Delta^4 ESI)_t$	0.02	0.06	0.17	0.07	0.04	0.04
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Adjusted R^2	0.80	0.35	0.85	0.87	0.87	0.82
D.W.	1.96	2.10	1.92	1.89	1.69	1.66

Table 1: The parameters are estimated via the OLS method using the `lm()` function of the `STATS R` package. In brackets are the p-values.

The analysis covers several periods (see Section 2), and this may represent a constraint in the comparison of results among countries. The traditional residual tests and graphical residual analysis do not evidence particular structures. As expected, the coefficient of the ESI variable is positive and statistically significant in each case. The elasticity magnitude is very close to zero in all countries investigated, except for Estonia (0.17). We now estimate relationship (1) considering the variable of ESI with a time-varying structure (2)[1]. As explained in the previous section, the time-varying effects are modelled using thin plate regression splines with 10 basis functions and third-order derivatives. As discussed in the relevant literature (e.g. Clarke *et al.*, 2006; Marra and Radice, 2008), the choice of the order of the derivatives for the smooth terms is somehow subjective and in fact it typically depends on the aim of the study and the data available for the analysis. It is usually set to 2, but in situations such as the cases being analysed here, the penalty can be based on third-order derivatives in order to model weak non-linear signals.

The main results are shown in Figure 2 and Table 2. The *edf* for the smooth term estimates are in all cases greater than 1 and their p-values support the hypothesis that the

[1]We use penalized regression splines instead of OLS rolling regression as a possible alternative to model the effects of the exogenous variable over time. This is because the main well known drawback of OLS rolling regression is that a window size choice has to be made and this can influence the results. The use of thin plate regression splines does not require any window size choice, and the estimates are not affected by this aspect.

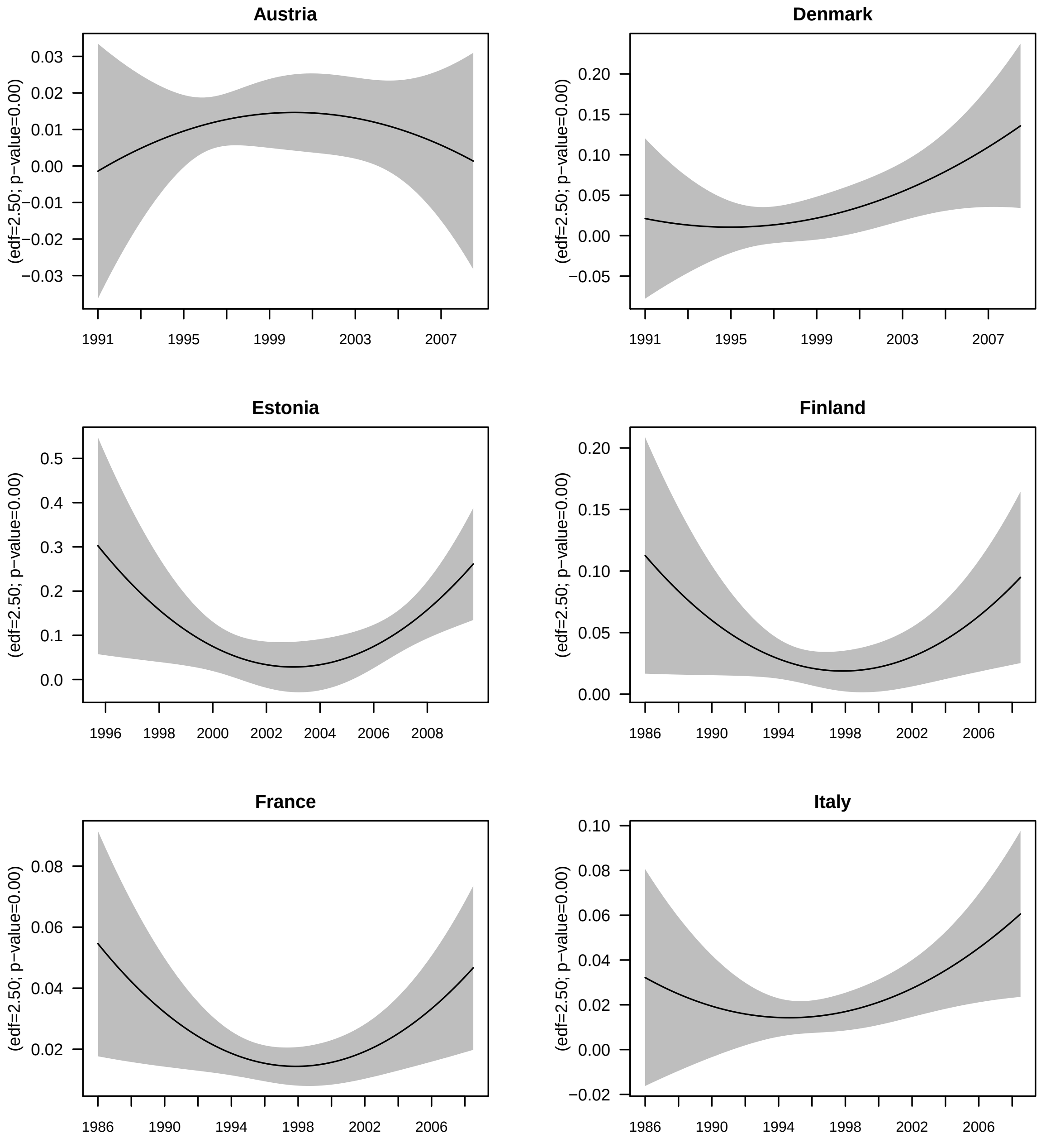

Figure 2: The solid line represent the estimated curve using the time-varying coefficient model (2) with penalized thin regression splines. The y-axis reports in brackets the *edf* of the smooth term and its p-value. The shaded regions represent 95% Bayesian Credible Intervals (see Marra and Radice (2008) for more details). The estimates are obtained using the `gam()` function of the `mgcv` `R` package.

Coefficients	Austria	Denmark	Estonia	Finland	France	Italy
Parametric coefficients:						
Intercept	2.26	2.06	7.17	2.62	2.14	1.68
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
$\theta(\Delta^4 ESI)_t$	0.01	0.03	0.03	0.02	0.01	0.02
	(0.01)	(0.07)	(0.31)	(0.02)	(0.00)	(0.00)
Approximate significance of smooth terms:						
$f_1(\Delta^4 y_t/y_{t-4})_{t-1}$	3.43	1.77	2.57	2.05	1.00	1.00
	(0.00)	(0.01)	(0.00)	(0.00)	(0.00)	(0.00)
$f_2(\Delta^4 y_t/y_{t-4})_{t-2}$	-	-	1.00	-	-	-
			(0.00)			
$s(t)(\Delta^4 ESI)_t$	2.50	2.50	2.50	2.50	2.50	2.50
	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)	(0.00)
Adjusted R^2	0.81	0.38	0.89	0.87	0.88	0.83

Table 2: The parametric coefficients θ represent the main effect. The *edf* of the smooth terms are shown for f_1, f_2 and $s(t)$. In brackets are the p-values. The estimates are obtained using the `gam()` function of the `mgcv R` package.

coefficients are statistically significant and time-varying. The residuals did not evidence any particular structures. Austria is the country with the lowest magnitude of the coefficient and a weak time-varying effect. For this reason, also a simple linear OLS approach may be appropriate. In all other cases, we found significant time-varying effects and an elasticity magnitude that at some points in time is very close to zero. This result points out as the explanatory power of the exogenous variable may be in some quarters weaker than in others where the elasticity magnitude is estimated to be highest. We remember that the ESI may suffers from the influence of sampling errors of a typical survey (see also the study of Van Oest and Franses (2008) on the changes in consumer confidence). It is also clear that not all of the complex economic aspects may be always well-captured by the questions asked to consumers and businesses. However, in our case as well as in others that are part of the body of economics literature, the ESI has shown a statistical significance, more or less robust, in the explanation of the behavior of macroeconomics variables.

5 Conclusions

In this article, the relationship between changes in the ESI and real GDP growth for six countries has been analysed. Interesting results from (i) graphic analysis and (ii) a econometric modelling have been presented. The first point refers to the fact that for the sample periods considered, the time series show at different time points that positive or negative changes in the ESI are not always accompanied by an increase or decrease in the real GDP. This effect may be partly due to the qualitative nature of ESI as well as to the methodology used to construct the composite index (see Section 1). As a possible focus, it might be interesting to study a customized ESI for each European country in order to better capture the dynamics of real GDP. However, from a graphical point of view the best co-movement between changes in the ESI and real GDP growth are found in France and Italy. As for the results of the second point, we take into account the econometric evidence of the relationship under study. In particular, Figure 2 show that the magnitude of the ESI estimated coefficients change in spatial terms and over time. Austria is the country with the lowest magnitude of the coefficient and with a weak time-varying effect as compared to the other countries investigated. The time-varying aspect is captured using penalized regression splines, and this article shows how this effect is masked if the ESI parameter estimates are obtained using a traditional approach such as OLS regression. The time-varying approach employed here improves the interpretation of the economic relationships discussed.

References

Bram, J. and Ludvigson, S.C. (1998) "Does consumer confidence forecast household expenditure? A sentiment index horse race" *Economic Policy Review* **4**, n. 2, 59–78.

Caroll, C.D., Jeffrey C.F. and David W. (1994) "Does consumer sentiment forecast household spending? If so, why?" *American Economic Review* **84**, n. 5, 1497–1408.

Clarke, E.D., Speirs, D.C., Heath, M.R., Wood, S.N., Gurney, W.S.C. and Holmes, S.J. (2006) "Calibrating remotely sensed chlorophyll-a data by using penalised regression splines" *Journal of the Royal Statistical Society Series C* **55**, 331–353.

Cotsomitis, J.A. and Kwan, A.C.C. (2006) "Can consumer confidence forecast household spending? Evidence from the European Commission business and consumer surveys" *Southern Economic Journal* **73**, n. 3, 597–610.

European Commission (2007) "The joint harmonised EU programme of business and consumer survey user guide" European Commission, DG Economic and Financial Affair, Economic Studies and Research, Business Survey.

Gelper, S. and Christophe, C. (2007) "The predictive power of the European Economic Sentiment Indicator" Working Paper, Department of Decision Sciences and Information Management, University of Leuven.

Gelper, S. and Christophe, C. (2010) "On the construction of the European Economic Sentiment Indicator" *Oxford Bulletin of Economics and Statistics* **72**, n. 1, 47–62.

Ginsburgh, V. and Zang, I. (2007) “Bundling by competitors and the sharing of profits” *Economics Bulletin* **12**, n. 16, 1–9.

Hastie, T. and Tibshirani, R. (1993) “Varying-coefficient models” *Journal of the Royal Statistical Society Series B* **55**, 757–796.

Marra, G. and Radice, R. (2008) “Penalised regression splines: theory and application to medical research” *Statistical Methods in Medical Research*. In press.

Katona, G. (1951) *Psycological analysis of economic behavior*, McGraw-Hill, New York.

Katona, G. (1977) *Psycological economics*, Elselvier, New York, Third Printing.

Ludvigson, S.C. (2004) “Consumer confidence and consumer spending” *Journal of Economic Perspectives* **18**, n. 2, 29–50.

Qiao, Z., McAleer, M. and Wong, W.K. (2009) “Linear and nonlinear causality between changes in consumptions and consumer attitude” *Economics Letters* **102**, n. 3, 161–164.

Van Oest, R. and Frances, P.H. (2008) “Measuring changes in consumer confidence” *Journal of Economic Psycology* **29**, 255–275.

Westerhoff, F.H. (2008) “Consumer sentiment and business cycles: a Neimark-Sarcher bifurcation scenari” *Applied Economics Letters* **15**, n. 15, 1201–1205.

Wood, S.N. (2003) “Thin plate regression splines” *Journal of the Royal Statistical Society Series B* **65**, 95–114.

Wood, S.N. (2006) *Generalized additive models: an introduction with R*, London: Chapman & Hall.