A MODEL FOR THE REAL-TIME FORECASTING OF GDP IN THE EURO AREA (EURO-STING)

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Introduction

The assessment in real time of economic developments in the very short term is a complex task. Primarily, because the macroeconomic variables needed to characterise the situation are released with a substantial lag and, occasionally, the data available are incomplete or insufficient. But also, moreover, because despite the greater abundance and more frequent availability of indicators of economic sentiment or of activity providing preliminary information on the behaviour of relevant macroeconomic aggregates, it is not immediately clear how to integrate in a structured form the occasionally contradictory information provided by these indicators.

To facilitate this integration, significant progress is being made in the development of real-time forecasting models that allow the different pieces of information of relevance for forecasting economic variables to be incorporated, as and when this information is available. This article presents such a model, designed for the real-time forecasting of the GDP growth rate in the euro area: the EURO-STING (Euro Area Short Term INdicator of Growth).[2]

A description of this model is first given. Next, the main results of its estimation are described, and its forecasting power set against some of the most commonly used alternatives on the European economic forecasting scene is assessed. Finally, some brief conclusions are drawn.

The forecasting model

Real-time forecasting models use various economic indicators to forecast relevant variables.[3] In the EURO-STING, the variable subject to forecasting is the quarter-on-quarter growth rate of GDP in the euro area for the current quarter and the following two quarters. The official data on this rate are provided by EUROSTAT in three waves: i) a preliminary announcement (a "flash" estimate), released six weeks after the end of the related quarter; ii) a "first" estimate, released around a fortnight later, and iii) a "second" estimate, out around 14 weeks after the end of the reference quarter. It is this second estimate which is subject to real-time forecasting by the EURO-STING.

Forecasting is based on indicators which refer either to economic agents' sentiment or to the actual behaviour of different sectors. More specifically, the model uses monthly indicators of economic activities such as the Industrial Production Index (IPI), the retail sales index, the index of new industrial orders (INO), and exports, whose release lags the reference month by between four and eight weeks. It also uses employment, as an indicator of quarterly economic activity, the lag in which is about six weeks. In addition, (monthly) survey-based indicators such as the indicator of Belgian economic activity (BNB), the indicator of euro area economic sentiment (ESI), the German economic climate indicator (IFO) and the indicators of manufacturing industry purchases (PMIM) and of services industry purchases (PMIS) are in-

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1. We are grateful to Camilo Alonso Ulloa and Carlos Vacas for their most valuable assistance in preparing this article and for the maintenance of the databases in real time. Without their work the real-time assessment of the model would not have been feasible, and nor would it be possible to update the forecasts on an ongoing basis. **2.** See Camacho and Pérez Quirós (2008) for a detailed description of the design, estimation and results of the EURO-STING. **3.** The design of the EURO-STING draws on Stock and Watson (1991), Mariano and Murasawa (2003) and Giannone, Reichlin and Small (2006), all designed for the US economy. A parallel model to ours, for the euro area, can be found in Angelini et al. (2008), where around 90 indicators are used.

cluded. In the case of survey-based indicators, there is no lag in the publication of the data as they appear in the closing days of each month to which they refer. Also forming part of the set of indicators in the model are the flash and first estimates of Eurostat, from the very first moment they are available.

The combining of different frequencies, different release dates, different sample periods and series revisions is carried out using dynamic factor models in which each of the series is decomposed into a common component and an idiosyncratic component. The model also allows for forecasting of the future behaviour of each of the indicators, meaning it is possible to analyse the effect on the GDP forecasts of the unexpected changes in the economic indicators.

In non-technical terms, the idea of the model is that there is first a common dynamic component (the business cycle) which helps simultaneously explain the behaviour of GDP and of all the indicators, and further an idiosyncratic component which determines the movements that do not respond to the dynamic of this common factor. Under these conditions, the movements of each indicator help anticipate, in part, the trend of the common component and, therefore, of GDP. Moreover, the more indicators tend to coincide in anticipating the same behaviour of the common factor, the greater will be the likelihood that this common factor is actually moving in the direction anticipated individually by each of them. The technical details on the workings of the model can be found in Camacho and Pérez Quirós (2008).

Empirical results

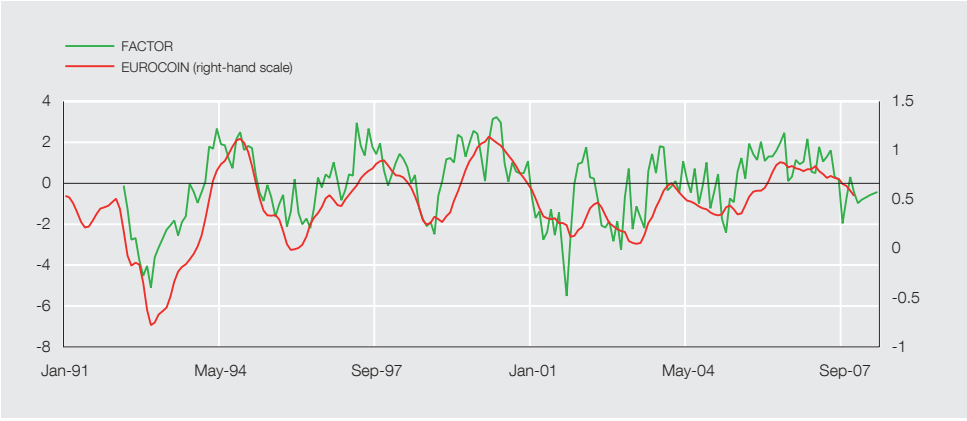
MODEL FUNCTIONING

EURO-STING allows a daily update of the forecasts. On each occasion the GDP figure is forecast for the latest as-yet-unreleased quarter and the two following ones. For example, on the latest information available to 9 January 2008, i.e. shortly after the end of 2007 Q4 and just after the release of the revised ("second") estimates for 2007 Q3, a forecast was made for GDP growth in 2007 Q4 and, with a greater degree of uncertainty, in the first two quarters of 2008. Later, once the revised GDP figure for 2007 Q4 has been released and incorporated into the model, the forecasting window shifts and covers the first three quarters of 2008. At each update of the model a forecast is made, moreover, of the forthcoming figure for each of the indicators. In this way, when each indicator is released, it is possible to identify which part of the released figure has been as expected and which unexpected, and to assess the impact of this on growth forecasting.

One initial and interesting result of the estimation of the model is that it does tend to corroborate the fact that the economic indicators used share a common factor that moves in step with what is traditionally considered "the European cycle". Chart 1 shows the common factor estimated by the model (in the left-hand scale) together with the Eurocoin (right-hand scale), an indicator published by the CEPR which is probably that most used by the literature on the European business cycle. As the chart shows, EURO-STING provides a common factor whose cyclical dynamic is similar to that of the Eurocoin, suggesting that it suitably reflects the cyclical behaviour of the euro area.

Table 1 sets out estimates of the impact of this common factor on each of the indicators used in the model, along with their standard deviations. In all instances, the estimates are positive and statistically significant, suggesting that the behaviour of the indicators used is procyclical. However, notable differences can be seen in the magnitude of the coefficients. The indicators of economic activities such as IPI, INO and GDP itself exhibit the highest estimates (0.21; 0.19 and 0.12, respectively). Yet the impact of the common factor on the survey-based indicators is constantly below 0.07. Nonetheless, this result cannot be interpreted as a symptom of the limited predictive power of these latter indicators; in a real-time forecasting setting, it is not only the predictive power of each variable that is important, but also the immediacy with which it is

COMMON FACTOR AND EUROCOIN (a) CHART 1



SOURCE: Banco de España.

a. Estimated factor (April 1992 - June 2008) and Eurocoin (January 1991 - December 2007). The latter is measured on the right-hand scale.

IMPACT OF THE COMMON FACTOR ON THE INDICATORS (a) (b) TABLE 1

Second	IPI	Sales	INO	Exports	ESI	BNB	IFO	PMIM	PMIS	Employment
0.15	0.21	0.06	0.19	0.12	0.05	0.06	0.05	0.07	0.07	0.10
(0.03)	(0.04)	(0.03)	(0.04)	(0.01)	(0.01)	(0.01)	(0.01)	(0.04)	(0.02)	(0.04)

SOURCE: Banco de España.

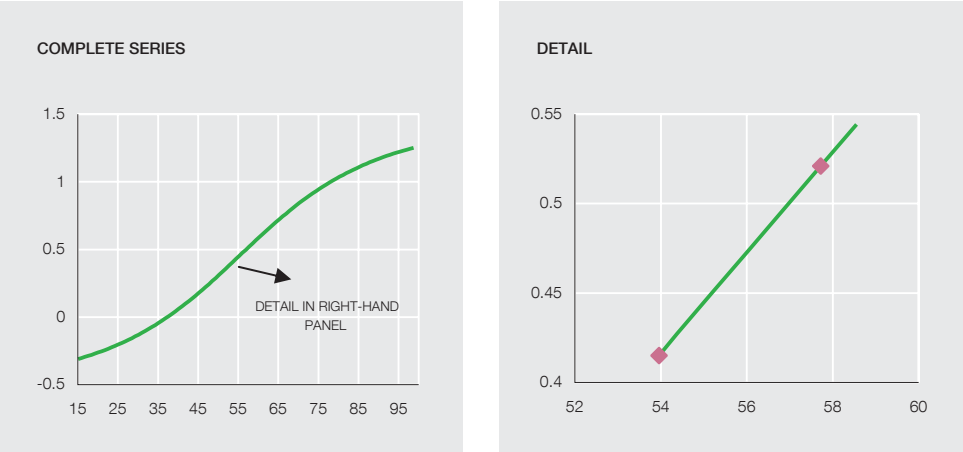
a. The values in brackets are the standard deviations.
b. The database used for the estimate relates to 9 January 2008.

available. It is the survey-based indicators that are first available and, therefore, even though they provide less information content than others, they do so at a time in which they are practically the sole source of information available. Indeed, their relative weight in the forecasting of GDP is very high at the beginning of each quarter, diminishing thereafter as more indicators of real activity containing more accurate information on developments in the common component become available.[4]

Chart 2 depicts an example of how the model functions when faced with the input of a new piece of information. More specifically, this chart illustrates how the forecasting of GDP changed in the face of a major surprise: the PMI services index of 21 September 2007. The expected value for this series was, according to the model, 57.7, and the forecast for growth in 2007 Q4 associated with this value was 0.52%. The chart firstly shows how the forecast for a broad range of possible PMI services outturns would have varied. The value the indicator finally took was 54, considerably below the forecast value. As a result, the EURO-STING interpreted the surprise in the indicator as relevant information on a negative performance of the common factor and consequently revised downwards the forecast of quarterly GDP growth to 0.41%.[5] This analysis, which can be conducted for all indicators included in the model, shows how EURO-STING provides an integrated framework for interpreting the novelty and relevance of each new figure, translating it directly into consequences in terms of more or fewer percentage points of GDP.

4. Bańbura and Runstler (2007) show that survey-based indicators have little predictive power in respect of European output other than that which is already included in the economic activity indicators. **5.** That same day the forecast fell by 0.1 pp more owing to the negative surprise in the PMIM.

JANUARY 2008 FORECAST AND VALUES OF PMI SERVICES (a) CHART 2



SOURCE: Banco de España.

a. Forecasts made as at 17 September 2008.

Table 2 summarises the main output obtained from the EURO-STING, once again taking the forecasts made on 9 January 2008 as a reference. This table provides readers with an overall view of the current economic situation and of its expected future course in the short term. Further, analysis of the changes over time in these "snapshots" of the situation at a given time allows for an alternative illustration of the functioning, in real time, of the model. More specifically, Chart 3 shows the forecasts that were made for 2007 Q4 on the basis of information emerging at each point in time. The chart enables the impact of the information associated with the financial turbulence that affected international markets in the summer of 2007 to be analysed. The first day the model provided forecasts of Q4 was on 12 June 2007, when the GDP figure for 2007 Q1 was released. Then, the forecasts were for growth of 0.63%. The first information referring to the financial turbulence was in the PMI services and manufacturing indices released in September, with values denoting declines of 3.83 and 1.13 points, respectively, not anticipated by the model. Moreover, the values of the other survey-based indicators such as BNB, IFO and ESI also depicted unanticipated declines of 1.8, 1.6 and 3.1 points, respectively. As the chart shows, the negative response of the growth forecast was immediate, falling to 0.3%. Subsequently, the survey-based indicators improved and the emergence of the initial data on economic activity were positive (especially the IPI, with growth of 0.5% in August), meaning that the forecast reached 0.4% at the end of the sample.

PREDICTIVE POWER

To assess how EURO-STING functions compare with alternative tools, a database has been constructed in which the information that was available at the time is used to make the forecast on each of the days between 2 January 2004 and 9 January 2008. Using the first of these 411 dates, a forecast of growth in the euro area in the following nine months is made. The model is re-estimated and the forecasts repeated until the last date in the database.[6]

Naturally, as in all real-time forecasting models, the degree of uncertainty of each forecast diminishes as the information set available to make it increases. For instance, Chart 3 shows how the confidence bands around the anticipated growth rate progressively narrow as new data from the indicators emerge. Chart 4 is based on a repetition of the example in Chart 3 for each of the quarters forecast by EURO-STING since the start of the sample period. Specifically, the chart

6. The model is re-estimated only for the first database of each quarter, making the forecast in real time with the parameters estimated in the first estimate for the quarter.

FORECASTS AS AT 9 JANUARY 2008 (a) TABLE 2

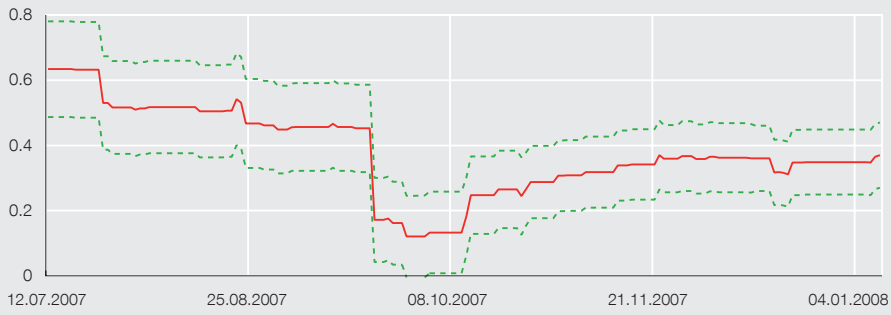
	GDP		
	2007Q4	2008Q1	2008Q2
SECOND	0.37	0.43	0.43
	(-0.102)	(0.122)	(0.143)

Indicators		
Series	Latest (b)	Forecast
IPI	0.44	-0.06
Sales	-0.50	0.52
INO	2.54	-1.40
Exports	0.26	0.02
ESI	104.70	104.21
BNB	-1.90	-2.15
IFO	103.00	102.57
PMI Man.	52.55	52.49
PMI Serv.	53.14	53.38
Employment	0.28	0.18
Flash	0.71	0.37
First	0.71	0.36

SOURCE: Banco de España.

a. The values in brackets are the standard deviations.
b. Refers to the latest known data for the indicator.

FORECASTS IN REAL TIME FOR 2007 Q4 (a) (b) CHART 3



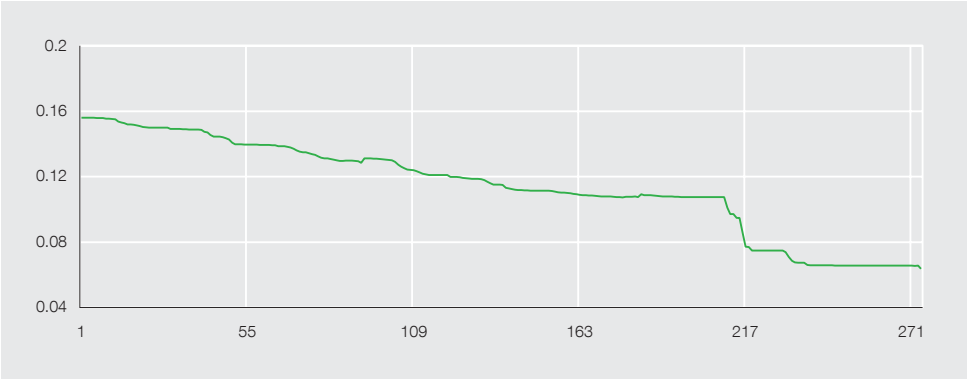
SOURCE: Banco de España.

a. Forecasts from 12 June 2007 to 9 January 2008.
b. The dotted lines plot the confidence bands of a standard deviation.

plots the average standard deviation of the growth forecast for each of the 275 days on which, on average, forecasts are made for a particular quarter. As can be seen, uncertainty about the forecast progressively diminishes thanks to the release of indicators. For the first 200 days of forecasting, volatility diminishes by approximately one-third. Around the day on which the flash estimate is released there is a sharp reduction in uncertainty. However, the decline in volatility associated with the release of the first estimate is much less, indicating that part of the information supplied by this estimate was already contained in the indicators released previously.

In addition, Table 3 analyses the predictive power of EURO-STING relative to that of other models which forecast short-run growth in the euro area. These include those of Eurocoin, IFO-INSEE-INSAE, the European Commission, the OECD and the DG ECFIN. It should be borne in mind that the forecasts of EURO-STING are updated daily while those of other models may go several months without being updated. However, for the purposes of this com-

AVERAGE STANDARD DEVIATION OF THE FORECAST (a) CHART 4



SOURCE: Banco de España.

a. The average is calculated for the sample in which the real-time forecasts are calculated.

parison, the EURO-STING forecasts for the same day and with the same information as that used in other models are taken.

In terms of the mean square error of the forecast, EURO-STING almost always produces the forecast with a lesser deviation from the figure actually released by Eurostat. Specifically, at any of the horizons considered, it is an improvement on the forecasts of Eurocoin, IFO-INSEE-INSAE and the European Commission. It also marks an improvement on the projections of DG ECFIN as the forecasting horizon increases, and its forecasts are even comparable with those of the OECD. It should be recalled that this comparison does not assess the main advantage of EURO-STING, namely the fact that its forecasts can be updated daily and that it is possible to quantify the impact that each new piece of information has on the forecasts.

Finally, it is worth comparing the EURO-STING forecast with that estimated by Eurostat when it releases its flash and first estimates. The flash estimate has a mean square error (relative to the figure published with the second estimate) of 0.024. With the flash estimate information incorporated, EURO-STING makes a forecast with a mean square error of 0.022. That is to say, although the flash estimate offers a very reliable lead on the final figure, if it is considered as one more indicator of activity and is complemented with the information from other indicators, as is the case with EURO-STING, the resulting forecast is ultimately even closer to the final result. The outcome is similar for the first estimate. The mean square error of the first estimate is 0.022, and the EURO-STING forecast once it incorporates the first estimate into its information set yields a lower mean square error of 0.014.

Conclusions

This article proposes a model, the EURO-STING, for the real-time, short-term forecasting of euro area GDP. The model is flexible enough to use indicators of economic activity and survey-based indicators, which may evidence different frequencies, lags in the publication of information, short samples and even incomplete data. It is also straightforward enough to allow a real-time assessment of its predictive power to be made. This approach further permits the efficient harnessing of the comparative advantages of indicators - such as survey-based indicators - which appear relatively early, and of those - such as leading indicators – which have greater information content but are released with a greater lag.

EURO-STING yields forecasts that are almost always closer to the final figure produced than other habitually used models. It also offers two further advantages. First, its forecasts are updated daily. And second, it makes forecasts not only of GDP but also of all the indicators

COMPARISON OF FORECASTS IN REAL TIME (a) TABLE 3

	Q1 FORECAST	Q2 FORECAST	Q3 FORECAST	TOTAL (b)
Eurocoin	0.083	0.046	0.042	0.057
EURO-STING	0.075	0.030	0.016	0.040
IFO-INSEE-ISAE	0.060	0.071	0.069	0.067
EURO-STING	0.044	0.048	0.037	0.043
European Commission	0.055	0.086	0.068	0.070
EURO-STING	0.028	0.071	0.033	0.044
OECD	0.019	0.049	0.036	0.035
EURO-STING	0.019	0.048	0.037	0.034
DG ECFIN	0.045	0.044	0.107	0.065
EURO-STING	0.046	0.033	0.052	0.044

SOURCE: Banco de España.

a. The values in the table are mean square errors for the forecasting period April 2003 - March 2007.
b. The last column is the average of the three forecast quarters.

useful for forecasting this variable. That makes it possible to assess the true information content of each piece of new information and to analyse quantitatively the extent to which this alters short-term forecasts of euro area GDP.

15.4.2008.

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