

## A REAL-TIME DISAGGREGATED FORECASTING MODEL FOR EURO AREA GDP

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### Introduction

Forecasting GDP in the short term is a complex task, among other reasons, because the macroeconomic variables required are published with a substantial lag, and as a result the available data are incomplete or insufficient. In this context, real-time forecasting models have demonstrated that they are a useful way of selecting the signals obtained from the relevant monthly indicators and combining them into an overall vision of developments in GDP growth. Noteworthy in this field is the methodology developed by Camacho and Pérez Quirós (2008) and implemented in the EURO-STING model, which incorporates various relevant pieces of information for forecasting euro area GDP as this information becomes available.

The EURO-STING and other related models have focused on forecasting changes in euro area GDP from an aggregate or direct perspective. Alternatively, however, an estimate of the growth in activity can be obtained indirectly by aggregating the forecasts for its different components. One of the further advantages of this approach is that it also provides very useful information for the conjunctural analysis since it evaluates separately the performance of the main sectors of production, of the expenditure components and of the various countries which make up the euro area. This is particularly important at times of change of cycle or of high uncertainty such as at present, when indicators, including economic agents' sentiment, which are published with a longer lead and, consequently, are a basic part of forecasts, and those which reflect the actual performance of various sectors or quantitative indicators, on which the National Accounts are based, may provide a different vision of developments in activity at aggregate level.

In this article a new forecasting model for euro area GDP growth is proposed, namely, EURO-STING DISAGGREGATED, which combines the direct and indirect approaches. Firstly, models are developed for each GDP component from the perspective of production, expenditure and the various countries. The forecasts obtained are aggregated according to the National Accounts rules in order to obtain three independent indirect estimates of quarter-on-quarter euro area GDP growth, to which the direct estimate obtained with the EURO-STING model is added [see Camacho and Pérez-Quirós (2008 and 2010)]. Next, these forecasts are mixed efficiently, taking into account their relative accuracy over time so as to extract a sign of activity growth in the most precise way. This methodology develops a broad enough model for the orderly inclusion of relevant information on the euro area and which, at the same time, is flexible since it efficiently combines four different approximations of GDP growth.

According to the historic evaluation of its predictive power, on average, EURO-STING DISAGGREGATED produces the most exact forecasts of GDP growth in the euro area for the period 2004-2011 of all the alternatives considered, furthermore it is the model which captures best both the depth of the recent crisis and the subsequent recovery rate.

The structure of the remainder of the article is as follows: the main indicators used for analysing economic activity in the euro area, as well as some of the problems faced by

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	Correlation with quarter-on-quarter rate of change of euro area GDP (%)				Lag in publication (days) (a)
	1999-2011	1999-2007	2008-2011	08-09 Recession	
Preliminary GDP (quarterly)					45
Qualitative indicators					
ESI (b)	85.7	71.8	84.1	88.1	0
Manufacturing PMI	86.6	83.9	88.6	91.7	-8
Services PMI	81.7	79.5	87.4	90.8	-8
IFO	54.0	66.5	70.7	79.9	-8
BNB	75.7	75.4	77.2	80.9	-8
Quantitative indicators					
Industrial production	89.3	78.9	91.2	90.1	42
Nominal exports	81.3	78.9	91.4	94.1	45
Industrial orders	69.9	31.5	86.7	87.0	52
Retail sales	30.9	37.6	-16.5	10.7	35
Employment (quarterly)	68.9	60.9	66.3	82.4	45

SOURCE: Banco de España.

a Lag between publication and end of reference period (month/quarter).

b In the case of the ESI, the correlation is calculated using the year-on-year rate of change of GDP.

short-term forecasting in the recent period are described in section two; the model is outlined in section three; its predictive power and functioning as a forecasting tool at the Banco de España are assessed in section four; and the conclusions are included in the last section.

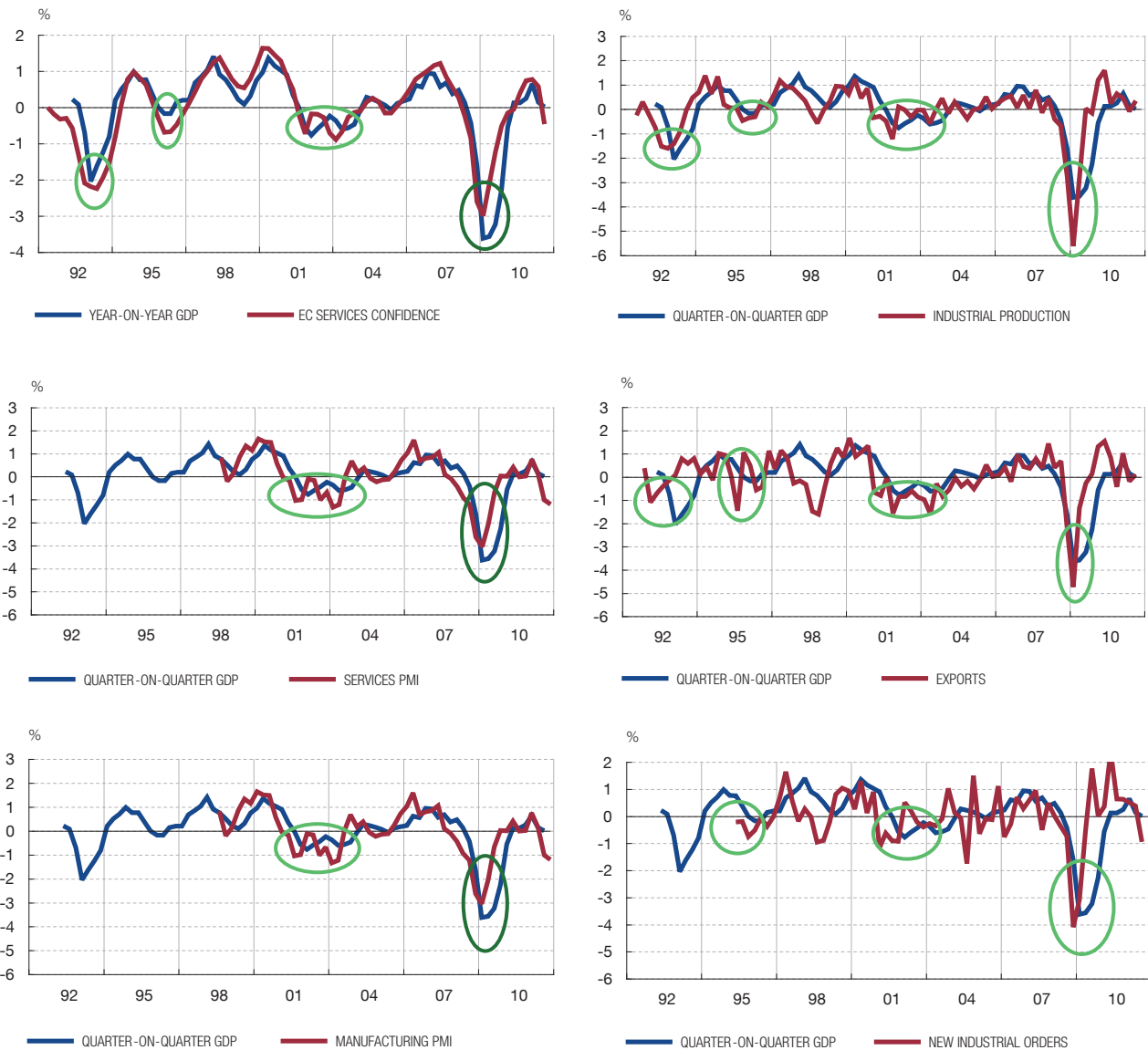
### Economic activity indicators

The short-term forecasting of economic activity is based on the analysis of various indicators that are closely related to GDP dynamics but which, in general, are published more frequently and with a slight lead with respect to the National Accounts. Among these indicators, there are qualitative indicators, which are released in the last few days of the reference month, thus anticipating the performance of activity with a substantial lead, and quantitative indicators, which are published later and are the basis for preparing the Quarterly National Accounts.

Table 1 includes the correlation between the quarter-on-quarter GDP growth rate in the euro area and the most relevant available leading indicators as well as the number of days of the lag between their release and the end of the reference period (month or quarter). In particular, the qualitative indicators which show the highest correlation with growth are the Economic Sentiment Indicator (ESI), published by the European Commission, and monthly surveys of purchasing managers in the manufacturing sector (PMIM) and in services (PMIS), published by Markit. The quantitative indicators most closely related to activity are industrial production and nominal exports which are released with a lag of approximately 45 days with respect to the end of the reference month. Note that all the correlations have increased considerably since the beginning of the last recession and peaked in 2008 and 2009 at values which were also higher than those seen during previous contractionary periods (1992 Q1-1993 Q1 and 2000 Q2-2001 Q4).<sup>2</sup>

However, as shown in Chart 1, the most important opinion indicators decreased less than GDP in the last recession, contrary to their performance in previous contractions, while

<sup>2</sup> The PMI, retail sales and industrial orders began to be published after that date.



SOURCES: European Commission, Eurostat and Markit Economics.

- a The series used include the first estimate of each data and are standardised for comparison purposes.
- b The dark (light) circles show periods when the indicator slipped much less (more) than GDP.

this was not the case for the most relevant qualitative indicators such as industrial production and exports.<sup>3</sup> Since opinion surveys are the indicators which are released with the longest lead, making them a key element of any short-term forecast, their smaller decline may be the reason why most of the short-term forecasts of euro area GDP based on real-time models underestimated the depth of the recession in 2008 Q4 and overestimated the speed of the recovery in the early quarters of 2009. This problem, nevertheless, has also affected projections made by analysts and public and private institutions which are not necessarily based on this methodology.

**The real-time forecasting model**

“Real-time forecasting models” use various economic indicators to predict the variable of interest. In general, these models have focused on forecasting changes in GDP from an

<sup>3</sup> The exception was employment, which declined less although this was due to extraordinary policies to maintain jobs.

aggregate or direct perspective. Alternatively, an estimate of activity growth can be obtained indirectly, by aggregating the forecasts for the GDP components. This perspective also provides very useful information for conjunctural analysis since it evaluates separately the performance of the main sectors of production, of expenditure components and, in the case of the euro area, of its various constituent countries.

The EURO-STING DISAGGREGATED model attempts to combine both approaches. In an initial phase, purely disaggregated modelling is adopted. Thus, although the final target variable remains the quarter-on-quarter GDP growth rate in the euro area, it is not forecast directly, but it is obtained by aggregating the projections of its most significant components from the perspective of production, expenditure and the various countries. In particular, 15 independent short-term forecasting models are developed following the EURO-STING methodology [see Camacho and Pérez-Quirós (2010)]. On the production side, the gross value added (GVA) of six sectors – agriculture, industry, construction, finance, the wholesale and retail trade, and other services – and taxes net of subsidies are modelled. On the expenditure side, total consumption, gross capital formation, exports and imports are considered. Finally, the four large countries are taken into account – Germany, France, Italy and Spain – which represent more than 80% of the euro area's GDP. In this way, all the relevant information about euro area activity is included in an orderly fashion, without the degree of correlation between the indicators of the various components being important.<sup>4</sup>

For this purpose, almost 100 indicators are used which are distributed among the 15 models estimated. Their size varies considerably, ranging from the GVA of agriculture, with only one indicator, to Germany's GDP, with 14. The starting point for selecting them was a broad set of variables which, in theory, should be related to the corresponding GDP component. On the production and expenditure side, the pre-selection made by Frale et al. (2011), plus the surveys of purchasing managers (PMI), is used. For the countries, the national component of the indicators considered in EURO-STING for the euro area is used together with the opinion surveys compiled by the most important institutions in each country, such as Germany's IFO and France's INSEE. The structure of the SPAIN-STING model developed at the Banco de España [see Camacho and Pérez-Quirós (2009)] is used for Spain. Subsequently, this list is reduced by analysing the degree of statistical correlation with the corresponding component and whether it contributes to improving the model's predictive power.

It should be underlined that the indicators included in each model can have a different frequency, release date and sample periods, thanks to the techniques developed by Camacho and Pérez-Quirós (2008).<sup>5</sup>

Next the projections of each component are aggregated according to the National Accounts rules in order to obtain three independent estimates of euro area GDP growth from the perspective of production, expenditure and the various countries. In addition to these three estimates there is the direct estimate of GDP growth provided by the EURO-STING model.

Finally, in order to obtain one single projection of activity growth in the euro area, the model efficiently mixes the projections obtained in the previous stage by using a measure

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<sup>4</sup> Álvarez et al. (2012) show that increasing the number of indicators included in a model does not necessarily improve its forecasts, especially when there is a high correlation with those indicators already included.

<sup>5</sup> Annex 1 details the allocation of the 100 indicators to each of the 15 models and Annex 2 shows an example of the macro table with the projections of EURO-STING DISAGGREGATED for the 15 components and the various approximations of GDP.

of their relative accuracy as a weight. In econometric literature there is no unanimity as to the optimal weights for mixing independent projections [Timmermann (2006)], and it is often found that the simplest rules work best in empirical studies. In this article several straightforward rules are proposed, the one that generates the most accurate forecast in a pseudo real-time evaluation exercise for the period is chosen. The most relevant results of this analysis indicate that the rule that generates the most accurate forecast combines the four GDP estimates obtained previously by using a weight for each one of them which is the inverse of their mean square error, calculated as the average of the three months of the last quarter published. Nevertheless, in the customary use of the model as a forecasting tool, the validity of these weights is reassessed periodically.

## Empirical results

When describing the empirical results, first the predictive power of EURO-STING DISAGGREGATED is tested along with its robustness in the face of the recent anomalous behaviour of opinion indicators and then the customary use of the model as a forecasting tool is described.

### EVALUATION OF PREDICTIVE POWER

In order to evaluate how EURO-STING DISAGGREGATED functions in comparison with alternative tools, two complementary exercises were performed. The first exercise, which covers the period 2004-2011, uses a monthly database compiled at the end of 2011 and, consequently, is called a “pseudo real-time evaluation”. Thus, the information in that database as of that date is attributed to each moment in time in order to make the projection in each month of the period considered. By using the first of those 96 dates, euro area growth is projected for the following three months. The model is re-estimated each month and the projections are repeated until the last date in the database. The second exercise is similar but uses a daily database which has been compiled in the last twelve months. In this case, the model is re-estimated each day that one of its almost 100 constituent indicators is released and a forecast is made for the current and following quarter.

Table 2 analyses the predictive power of EURO-STING DISAGGREGATED compared with that achieved by other models which forecast short-term growth in the euro area. The forecasts included are those of: Eurocoin (probably the most frequently used indicator in literature related to Europe’s economic cycle which is published by the CEPR and the Banca d’Italia); the Euro-Zone Economic Outlook prepared jointly by the IFO, INSEE and INSAE research institutes; the European Commission; the OECD; the Euro Zone Barometer (the result of a monthly survey by MJEconomics of the main economic analysts); and EURO-STING.<sup>6</sup> In terms of the projection’s mean square error, EURO-STING DISAGGREGATED always produces the forecast with the lowest deviation from the data actually published by Eurostat. Specifically, it is a substantial improvement on alternative forecasts both for the complete sample and for before and during the last crisis. Similarly, this is the most precise model for the real-time exercise performed with daily data from 2011. In every case but one, the second best estimate corresponds to the Banco de España’s EURO-STING model which, in turn, is a component of the optimal estimate of EURO-STING DISAGGREGATED.

Finally, in order to evaluate the robustness of this model at times of change of cycle and high uncertainty, Chart 2 compares the estimate (in pseudo real time) of the best three projections for the last four years. In this period, EURO-STING DISAGGREGATED is the

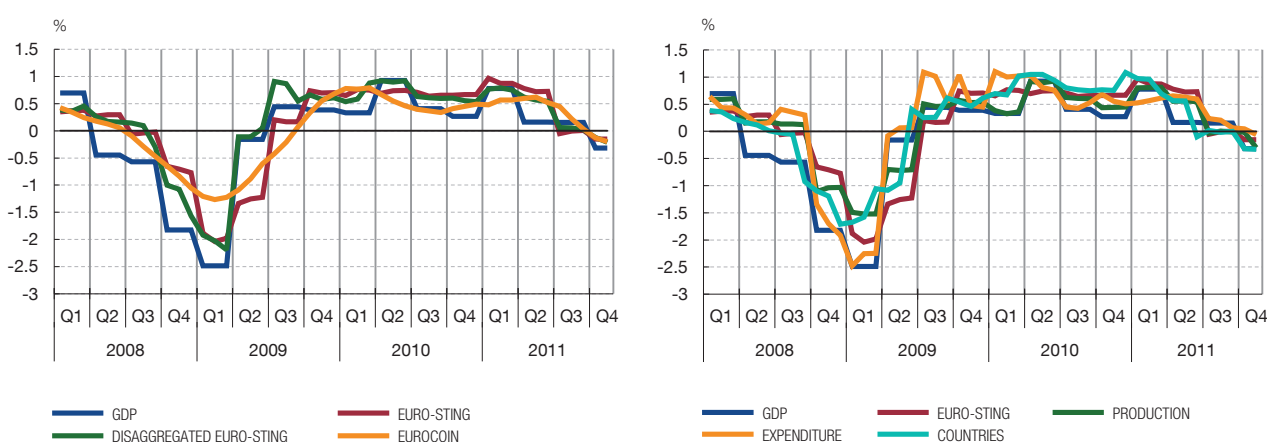
<sup>6</sup> In the real-time evaluation exercise the quarterly projections published by IFO-INSEE-INSAE, the European Commission and the OECD are excluded due to the low number of observations.

Model/institution	Pseudo real time			Real time
	2004-2011	2004-2007	2008-2011	1 Mar 2011-14 Feb 2012
Eurocoin	2.18	2.77	2.05	4.06
Eurobarometer	8.77	—	5.05	4.87
IFO-INSEE-ISAE	3.78	4.07	3.89	—
OECD	4.51	1.92	4.66	—
European Commission	4.63	1.13	5.00	—
EURO-STING	2.06	1.46	2.16	1.24
DISAGGREGATED EURO-STING	1.00	1.00	1.00	1.00

SOURCE: Banco de España.

COMPARISON OF FORECASTS IN PSEUDO REAL TIME OF THE EURO AREA

CHART 2

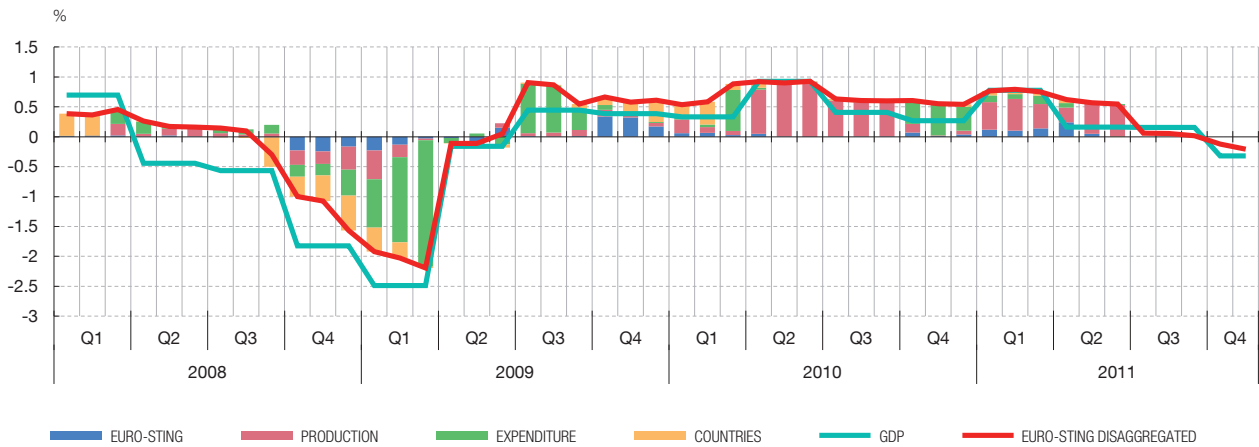


SOURCES: Banco de España and CEPR.

model which produces the best approximations of the depth of the crisis and the subsequent recovery rate. Furthermore, when this forecast is broken down into the part explained by each of the GDP approximations (see Chart 3), it is observed that the expenditure side captures the depth of the crisis best, whereas the production side contributes most during the low-growth period recorded in 2010 and 2011. This result confirms that the two characteristics which define the EURO-STING DISAGGREGATED model, namely the orderly incorporation of a very high number of indicators and the flexibility granted by efficiently mixing four different estimates of the target variable, make this model accurate and robust at the same time.

#### THE FUNCTIONING OF EURO-STING DISAGGREGATED AS A FORECASTING TOOL

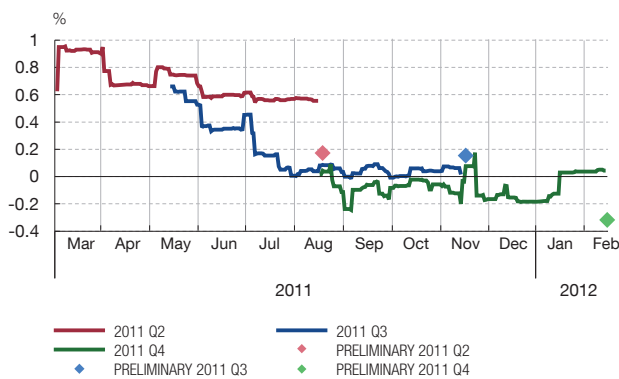
As part of its customary use as a forecasting tool at the Banco de España, the projections of EURO-STING DISAGGREGATED are updated each day an indicator is published or when one published earlier is revised. On each occasion, the GDP data for the most recent quarter, which has not been published, and the following quarter is projected for the four approximations considered (production, expenditure, the various countries and the aggregate) and the best combination of the latter. Once the first estimate of the data which were being forecast is published – approximately 45 days after the end of the quarter for



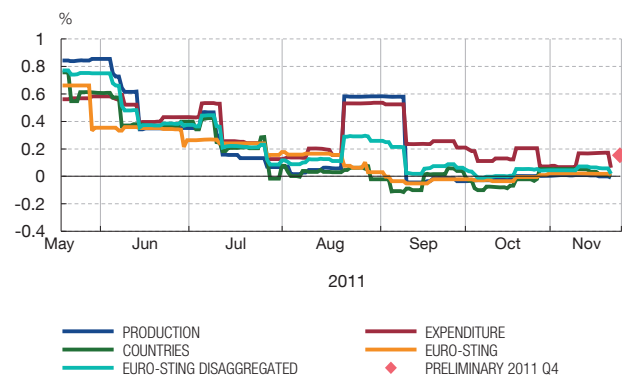
Sources: Banco de España and Eurostat.

THE FOUR ESTIMATES IN REAL TIME OF EURO AREA GDP AND THE BEST MIX

EURO-STING DISAGGREGATED. FORECAST OF EURO AREA GDP



ESTIMATES OF EURO AREA GDP 2011 Q2



SOURCE: Banco de España.

the GDP of the euro area or the countries, and around 75 after for the other components – the forecasting window is moved one quarter. Each time the model is updated, the next data is forecast for each of the 100 indicators considered. Thus, when each indicator is published it is possible to identify which part of the data was in accordance with expectations and to calculate the impact of the unexpected part on the GDP component or components to which it is related, as well as on each of the growth approximations considered and the best combination of them. For this purpose, from 1 March 2011 a daily database has been compiled with the model’s 100 constituent indicators.

By way of illustration, Chart 4 shows the estimates made of GDP growth in the area in the last three quarters (left-hand panel) and, for the third quarter of the year, the estimates resulting from the four GDP approximations of the EURO-STING DISAGGREGATED model (right-hand panel). Thus, for example, these charts make it possible to analyse the impact of the information associated with the turmoil due to the euro area sovereign debt crisis during 2011 Q3. The first day that the model provided projections for Q3 was 10 May, following the release of the GDP data for 2011 Q1. At that time the projections were for growth of 0.78%. The first information available on that period were Markit’s purchasing managers’ surveys and the

European Commission's surveys, which at end-July showed significant falls not anticipated by the model in all its components and sectors, both for the euro area and the large countries. As seen in the Chart, the growth projection, which had already slipped in previous months, recorded a considerable fall to 0.1%. The agreement reached at end-July by the Heads of State or government and the reactivation of the European Central Bank's programme of sovereign debt purchases eased market strains which was reflected in an improvement in the opinion surveys published at end-August and improved the forecast temporarily to 0.3%. However, the publication at the beginning of September of the first quantitative indicators referring to July, which recorded worse-than-expected values, led the forecast to values of close to zero where it held until the end of the sample in November. The preliminary data for Q3 published on 14 November recorded growth of 0.15%.

## Conclusions

In this article EURO-STING DISAGGREGATED is proposed as a model for real-time short-term forecasting of the quarter-on-quarter growth rate of euro area GDP, as well as of 15 of its components from the perspective of production, expenditure and the various countries and their respective aggregates. EURO-STING DISAGGREGATED is broad enough to incorporate in an orderly fashion all the relevant conjunctural information for the short-term forecasting of euro area GDP (almost 100 indicators) and, at the same time, it is very flexible since it combines four different approximations of GDP. Due to these two characteristics the forecasting of EURO-STING DISAGGREGATED is particularly robust at times of change of cycle and of high uncertainty, when opinion indicators and monthly data are likely to show contradictory signs.

Similarly, it should be recalled that as a result of the methodology used by each of the models that make up EURO-STING DISAGGREGATED, it is possible to include indicators of varying frequency, with lags in the publication of information, short samples and even incomplete data. This approach, furthermore, efficiently uses the comparative advantages of the indicators which, such as those based on opinion surveys, appear relatively early and of those which, such as leading activity indicators, have a higher information content but appear with a longer lag.

Finally, this paper shows that EURO-STING DISAGGREGATED produces forecasts which are, on average, closer to the final value of the GDP growth rate than other models usually employed and has, furthermore, two additional advantages. The first is that its projections are updated daily. The second is that the model provides projections not only of GDP and its components but also of the almost 100 indicators used to forecast the latter, which makes it possible to assess the true information content of each piece of new information and to quantitatively analyse to what extent said information modifies short-term projections of euro area GDP.

9.3.2012.

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## ANNEXES

Tables:

Annex 1 EURO-STING DISAGGREGATED indicators.

Annex 2 Macroeconomic table with the projections of EURO-STING DISAGGREGATED of 2 November 2011.

Approximation: production		Approximation: expenditure		Approximation: large countries	
GVA: agriculture, hunting and fishing	q	Final consumption	q	GDP: Germany	q
GVA: industry (incl. energy)	q	Retail sales	m	Industrial production	m
Industrial production	m	Unemployment rate	m	New industrial orders	m
IP: intermediate goods	m	EC consumer confidence	m	Retail sales	m
Industry employment	m	EC financial situation	m	Total employment	q
Hours worked in industry	m	EC general economic situation	m	Exports	m
EC industrial confidence	m	EC propensity to buy durable goods	m	Imports	m
EC order books assessment	m	Composite PMI output	m	EC industrial confidence	m
Manufacturing PMI, output	m	Composite PMI incoming business	m	EC services confidence	m
Manufacturing PMI, orders	m	Gross capital formation	q	ZEW indicator	m
Manufacturing PMI, foreign orders	m	Industrial production	m	IFO indicator	m
GVA: construction	q	IP: capital goods	m	GFK indicator	m
IP: construction	m	EC industrial confidence	m	Manufacturing PMI	m
Construction employment	m	EC output trend	m	Services PMI	m
Hours worked in construction	m	EC order book assessment	m	GDP: France	q
EC industrial confidence	m	Composite PMI output	m	Industrial production	m
Construction PMI, new orders	m	Composite PMI incoming business	m	New industrial orders	m
Construction PMI, real estate activity	m	Exports	q	Retail sales	m
Construction PMI, civil engineering activity	m	IP: intermediate goods	m	Total employment	q
GVA: wholesale & retail trade, trans. & comm.	q	Real effective exchange rate	m	Exports	m
IP: consumer goods	m	EC order book assessment	m	Imports	m
Employment in wholesale and retail trade	m	Imports	q	EC industrial confidence	m
Retail sales	m	IP: intermediate goods	m	EC services confidence	m
EC price trend	m	Real effective exchange rate	m	INSEE industrial confidence	m
EC wholesale and retail trade activity	m	EC order book assessment (CDE)	m	Manufacturing PMI	m
EC confidence in consumption	m			Services PMI	m
EC industrial confidence	m			GDP: Italy	q
EC order books assessment	m			Industrial production	m
EC order books assessment (CDE)	m			New industrial orders	q
Composite PMI output	m			Retail sales	m
Composite PMI incoming business	m			Total employment	m
GVA: financial services	q			Exports	m
M3	m			Imports	m
EC output trend	m			EC industrial confidence	m
Composite PMI output	m			EC services confidence	m
Composite PMI incoming business	m			ISAE industrial confidence	m
GVA: other services	q			Manufacturing PMI	m
Central government debt	m			Services PMI	m
GVA: net taxes	q			GDP: Spain	q
Industrial production	m			Industrial production	m
Retail sales	m			VIGES	m
EC output trend	m			Overnight stays in hotels	m
EC consumer confidence	m			Cement consumption	m
				Social security registrations	m
				Exports	m
				Imports	m
				EC industrial confidence	m
				EC retail sales confidence	m
				Services PMI	m

SOURCE: Banco de España.

NOTE: EC - European Commission; IFO - Information and Forschung (research); INSEE - Institute for Statistics and Economic Studies; ISAE - Istituto di Studi e Analisi Economica; m - monthly frequency; PMI - Purchasing Managers' Index; q - quarterly frequency; VIGES - Wholesale corporations' sales; ZEW - Centre for European Economic Research.

	2008	2009	2010	2010				2011			
				Q1	Q2	Q3	Q4	Q1	Q2	Q3	Q4
<b>Euro area production</b>											
Agriculture	1.3	2.8	0.1	0.91	-0.61	-0.86	0.60	0.61	-0.21	0.18	0.25
Industry	-2.4	-13.1	6.3	2.19	1.91	0.75	1.28	1.77	0.39	-1.12	-1.61
Construction	-1.6	-6.2	-4.1	-1.70	1.04	-1.07	-1.32	2.50	0.10	0.34	-0.18
Trade, trnspt. and communications	1.4	-5.3	2.4	0.61	1.02	0.68	0.00	0.61	0.20	0.02	-0.40
Financial services	1.6	-1.6	1.0	0.14	0.38	0.59	0.32	0.21	0.17	0.31	0.09
Other services	2.0	1.3	0.9	0.11	0.13	0.08	0.12	0.25	0.17	0.33	0.36
Taxes less subsidies	-1.4	-3.9	1.3	-1.22	2.50	0.50	0.03	1.19	-0.23	0.18	0.23
Gross domestic product (production)	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.01	-0.22
<b>Euro area expenditure</b>											
Consumption (private + government)	0.9	-0.2	0.8	0.15	0.21	0.22	0.22	0.22	-0.21	0.26	0.17
Gross capital formation	-1.5	-15.7	4.2	2.38	3.22	0.42	0.09	3.51	0.53	-0.88	-1.59
Exports	1.0	-12.8	10.1	3.01	4.16	1.83	1.23	1.38	0.73	1.03	1.78
Imports	0.9	-11.7	9.3	3.81	3.91	1.50	1.09	1.60	0.20	1.00	0.54
Gross domestic product (expenditure)	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.07	0.35
<b>Four large countries</b>											
Germany	1.9	-4.0	4.3	0.51	1.95	0.79	0.48	1.35	0.12	-0.18	0.34
France	2.5	-2.3	2.3	0.15	0.50	0.42	0.33	0.91	0.01	-0.19	-0.01
Italy	1.3	-3.1	1.9	0.64	0.48	0.31	0.07	0.14	0.30	-0.77	-0.54
Spain	3.3	-3.7	0.3	0.09	0.32	-0.02	0.21	0.38	0.16	0.15	-0.23
Gross domestic product (countries)	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	-0.26	-0.03
<b>Euro area gross domestic product</b>											
EURO-STING	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.02	-0.14
Production + expenditure	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.03	-0.09
Production + expenditure + countries	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.04	-0.12
DISAGGREGATED EURO-STING	0.4	-4.2	1.8	0.33	0.93	0.41	0.27	0.78	0.16	0.04	-0.12

SOURCE: Banco de España.

- a Quarter-on-quarter rates of change.  
b The shaded areas relate to forecasts.

