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EUROSYSTEM

WORKING PAPER SERIES

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In 2008 all ECB publications feature a motif taken from the €10 banknote.

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CONTENTS

Abstract

Short-term fiscal indicators based on public accounts data are often used by European policy makers. They represent one of the main sources of publicly available intra-annual fiscal information. Nevertheless, these indicators have received limited attention from the academic literature analysing fiscal forecasting in Europe. Some recent literature suggests the validity of public accounts data to forecast government deficits in the euro area. We extend this literature on two fronts: (i) we shift the focus from indicators of government deficits to look at indicators for government total revenue and total expenditure; (ii) we use a mixed-frequency state-space model to integrate readily available monthly/quarterly cash-based fiscal data with annual general government series (National Accounts). By doing so, we are able to maintain the focus on forecasting and monitoring annual outcomes, while making use of infra-annual fiscal information, available within the current year. The paper makes a case for the use of monthly cash indicators for multilateral fiscal surveillance at the European level.

JEL Classification: C53; E6; H6.

Keywords: Leading indicators; Fiscal forecasting and monitoring; Euro area.

Non-technical summary

The multilateral fiscal surveillance system in Europe is based on a recurrent evaluation of short- to medium term budgetary plans of European Union (EU) member states. The bases for the evaluation of budgetary plans are the Stability and Convergence Programmes, submitted annually (by the end of each year) by EU member states to the European Commission (EC) and the Council of the EU. Once a year, thus, EU institutions analyse in depth the compliance of member states' plans with the EU fiscal policy framework. The whole EU multilateral surveillance set-up is based on the evaluation of annual ESA95 fiscal data and targets. Intra-year updates of fiscal plans laid out in Stability and Convergence Programmes occur in Spring and Autumn of each year.

The use of intra-annual fiscal information to monitor and forecast fiscal targets in the short-run is warranted in the EU fiscal policy framework. A relevant source of intra-year fiscal information can be found in governments' public accounts. Monthly and quarterly cash data of the central government sector and other sub-sectors of the general government are published regularly and timely, with a wide coverage of revenue and expenditure categories. Their use tends to be controversial in the policy arena given concerns about coverage (usually referred to central government) and statistical definitions. Nevertheless, from the econometric point of view, a recent strand of the literature finds evidence in support of the usefulness of cash deficit figures. The current paper has to be seen as a contribution to this literature.

On the data coverage side we move this literature beyond fiscal deficit series. First we provide in-sample quantitative information for the link between a wide, disaggregated set of cash indicators (up to 50 revenue and expenditure items, for 10 euro area countries) and annual ESA95 fiscal variables. Second, we present an out-of-sample exercise for a subset of variables (total revenue and total expenditure for 8 euro area countries).

On the methodological side, first we estimate Error Correction Models for the in-sample exercise. Second, for the out-of-sample exercise, in contrast with a standard bridge equations approach we shape and estimate a mixed-frequency state-space model to integrate readily available monthly cash data with annual general government series. By doing so, we are able to maintain the focus on forecasting and monitoring annual outcomes, while making use of infra-annual fiscal information, available within the current year.

The paper makes a strong point for the use of monthly cash indicators for multilateral fiscal surveillance at the European level.

1. **Introduction**

The multilateral fiscal surveillance system in Europe is based on a recurrent evaluation of short- to medium term budgetary plans of European Union (EU) member states. The bases for the evaluation of budgetary plans are the Stability and Convergence Programmes, submitted annually (by the end of each year) by EU member states to the European Commission (EC) and the Council of the EU. Once a year, thus, EU institutions analyse in depth the compliance of member states' plans with the EU fiscal policy framework.

The whole EU multilateral fiscal surveillance system is based on the evaluation of annual ESA95 general government budget data and targets. Intra-year updates of fiscal plans laid out in Stability and Convergence Programmes occur in Spring and Autumn of each year, when Member states report to the EC updated fiscal figures for the previous year, and updated fiscal targets for the current year (Spring notification) or a year ahead (Autumn notification). On many occasions there have been sizeable revisions to annual fiscal figures compared to initial estimates in many recent historical episodes (see Gordo and Nogueira Martins, 2007, Bier, Mink and Rodriguez Vives, 2003). For international organizations and market participants it is sometimes difficult to challenge ex-ante member states preliminary estimates of annual figures for the current year, given the lack of available statistical information at the time these preliminary estimates are released. [1]

Even with these serious limitations, the existing intra-annual fiscal information has no formal role in the multilateral surveillance process of the EU. One source of intra-annual information that could be potentially integrated in the EU multilateral fiscal surveillance process can be found in governments' cash-based Public Accounts. Monthly and quarterly cash data of the central government sector and to a lesser degree of other sub-sectors of the general government are published regularly and timely, with a wide coverage of revenue and expenditure categories. Their use tends to be controversial in the policy arena given concerns about coverage (usually restricted to central government) and statistical definitions. [2] Pérez (2007) analyses the link of cash fiscal deficits and annual ESA95 deficits in Europe and finds strong evidence in support of the usefulness of cash government deficit figures for a panel of nine euro area countries. Other somewhat related papers that analyse the usefulness of monthly budgetary (cash) figures to monitor annual budgetary outcomes are the country

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[1] For an analysis of a review of issues on fiscal forecasting in Europe see Leal *et al.* (2007).

[2] Mainly the fact that they tend to follow cash principles instead of the accrual principle in national accounts, but also the fact that for some countries and variables the definitions, coverage and compilation rules have changed over time.

studies by Kinnunen (1999) for Finland, and Silvestrini, Moulin, Salto, and Veredas (2007), for France. [3]

The current paper has to be seen as a continuation of Pérez (2007) insofar as it uses intra-annual data taken from the cash accounts of the governments to develop early warning tools for the evolution of annual ESA95 figures for the General Government sector. Our study makes important progress in two fronts.

On the data coverage side we move beyond fiscal deficit series. First, we provide in-sample quantitative information for the link between a wide, disaggregated set of cash-based fiscal indicators and annual ESA95 fiscal variables. We cover up to 50 revenue and expenditure items, for Belgium, Germany, Spain, France, Greece, Italy, the Netherlands, Austria, Portugal and Finland. [4] Second, we present an out-of-sample exercise for a subset of variables (total revenue and total expenditure for 8 euro area countries).

On the methodological side, first we estimate Error Correction Models for the in-sample exercise. Second, for the out-of-sample exercise, in contrast with the bridge equations approach in Pérez (2007) we shape and estimate a mixed-frequency state-space model to integrate readily available monthly cash data with annual general government series. By doing so, we are able to maintain the focus on forecasting and monitoring annual outcomes, while making use of infra-annual fiscal information, available within the current year. [5] The paper makes a strong point for the use of monthly cash indicators for multilateral fiscal surveillance at the European level.

The paper is organized as follows. Section 2 describes the data used. Section 3 provides the in-sample quantitative evidence for the broad set of fiscal variables. Section 4 describes the

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[3] The literature on revenue forecasting using monthly and quarterly central government data is quite developed for the US, and to a lesser extent for the UK. The empirical works for the US tend to focus on forecasting tax revenues for the individual States, given the need to achieve an end-of-year balanced budget (as, for example, Fullerton, 1989 or Lawrence, Anandarajan and Kleinman, 1998). Public Accounts budgetary figures could also be used as a companion to the available quarterly ESA95-based Eurostat series (in this respect see Pedregal and Pérez, 2007, and EC, 2007).

[4] On purpose, the number of analysed variables in this part is not uniform across countries. The rule for inclusion of a variable has been its availability in the public domain. All variables included in our analysis could have been found by an anonymous EU citizen not having access to private databases but only to the Internet, and having enough patience to build up a database by such means.

[5] The methodology can be easily implemented for short-term monitoring of public finances in real-time. A companion MATLAB program is available from the authors upon request.

mixed-frequencies modelling approach followed in the paper. Section 5 provides out-of-sample quantitative evidence based on the estimated models. Section 6 concludes.

2. Data description

This paper uses two different sets of government finance statistics, as the so-called Public Accounts (cash-based) are used as an early indicator of the corresponding National Accounts (ESA95) series (accruals basis). Two considerations emerge. On the one hand, the Public Accounts have to be used with care, as the accounting procedures, the methods of compilation of data, timing of recording of transactions, as well as the coverage of budgets differ from country to country and over time. On the other hand, Public Accounts are more timely available and at higher frequencies (normally monthly), therefore they may constitute a valid early indicator of the National Accounts (ESA95) series. For a deep analysis of the detailed accounting rules and conventions involved in the compilation of the Net Borrowing/Net Lending of the General Government, and the differences between National Accounts and Public Accounts, the interested reader may consult Eurostat (2002) for National Accounts-related matters, and http://dsbb.imf.org for Public Accounts specific features.

Throughout the paper we will refer to the series selected from the Public Accounts as *indicators*. The database of Public Accounts has been assembled through an extensive search on the Internet, limiting ourselves to publicly available data. Public Accounts data are typically disseminated through the monthly publications of the General Accounting Offices, National Statistical Institutes, Ministries of Finance and National Central Banks of the respective countries. In many cases it has been necessary to construct the time series by retrieving the data month by month from the latest publications. To update latest developments, the latest monthly figure and the previous one are also published on the International Monetary Fund (IMF) website, in the Special Data Dissemination Standard (SDDS) section, to which all Euro Area Member States contribute. Aiming at a harmonisation of national practices in the process of compilation and publication of Public Accounts, the SDDS pages of the IMF provide methodological information on sources of publication, timeliness and coverage of Public Accounts.

Our selected public accounts data cover different samples, beginning in the early 1970s for most countries (like France, Austria, Italy and Belgium), in 1984 for Spain and only in 1997 for Portugal. They generally cover the central government, therefore excluding regional and local authorities (partial exceptions are Belgium and Germany, for which more disaggregated data are reported, and for Italy, where a Public Sector definition of deficit is also available).[6, 7]

The definitions and sources of Public Accounts series used in this paper are displayed in Table 1.

[TABLE 1]

The source of all annual National Accounts data for General Government and Gross Domestic Product (GDP) is AMECO, the annual macroeconomic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN). The main data source for AMECO is Eurostat, the Statistical Office of the EU. Data from AMECO cover the period 1970-2007. ESA79 figures are taken for the period 1970 to 1990, while ESA95 figures are used for the years 1991 to 2007. An exception is Spain, where ESA95 figures are only available from 1996, and thus ESA79 figures are used for 1991-1995.[8]

Figure 1 presents for some selected countries (Germany, Spain, France, Italy and the Netherlands) the General Government National Accounts series and the annualised monthly cash indicators for deficit, total revenue and total expenditure as a percentage of GDP.

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[6] Some indicator series had to be interpolated due to the existence of missing values (For France, January and February of the years 1970, and 1976-1993; in Austria the fourth quarter of 1985 and 1986) or the presence of sizable outliers (in 1986, 1987 and 1994 in the Netherlands; Ireland July and December 1999). The impact of one-off proceeds relative to the allocation of mobile licenses (UMTS) was removed from the ESA95 series and, accordingly, some adjustments were also implemented in the quarterly indicators to guarantee consistency. Some discontinuities/breaks in the cash series had to be corrected using the program TRAMO/SEATS of Gómez and Maravall (1996). Some examples are related to 2002 in Spain, where some devolution of resources from the central government to the regions shows up as a jump in the level of some indicators, which cover only the central government, but not the general government (target) variables, where such changes net out in the aggregation of the statistics at the general government level.

[7] National currency data for all years prior to the switch of the country to the euro have been converted using the fixed euro conversion rate in order to provide comparable series across time for each country.

[8] The vintage of the AMECO database used was the one available in spring 2007.

[FIGURE 1]

A first look at the charts seems to provide some evidence that in most cases a long-run relationship between the cash indicator and the ESA95 variable exist. As regards deficit series as a percentage of GDP it is apparent from the charts that there is a strong medium-term relationship, coupled with short-term deviations that tend to be corrected when new observations are incorporated. The information regarding total revenue and total expenditure series is displayed in a different format given the clear non-stationary behaviour of the series: we chose to show changes in the total revenue and total expenditure ratios to GDP. From the second and third columns of Figure 1 two features can be highlighted: first, for many countries there is a strong co-movement between the changes in the revenue/expenditure ratio measured in ESA95 terms and the changes of the revenue/expenditure ratio measures in cash terms; second, positive/negative changes in the revenue/expenditure ratio measured in ESA95 terms tend to be accompanied by positive/negative changes of the revenue/expenditure ratio measures in cash terms.

3. In-sample quantitative evidence

A first piece of quantitative evidence validating the two features underlined in the previous paragraph (long-run relationship, short-run co movement) can be provided by econometric models, using as a predetermined variable the indicator, and as endogenous variable the General Government deficit. Note that an indicator series can be deemed as predetermined in that it is updated monthly, and thus its annual value is known in advance of the General Government variable. A suitable set of econometric models designed to capture both short- and long-run relationships are the Error Correction Models (ECM henceforth, see Engle and Granger, 1987).

[TABLE 2, TABLE 3]

In a preliminary stage, following the usual methodology, tests on the order of integration of the series were performed, showing that in the great majority of cases the null hypothesis of a unit root in the series could not be rejected at conventional test sizes (Table 2).

Second, we test the existence of a long-run relationship between the indicator and the National Accounts. Table 3 reports the results of ADF tests. [9] For robustness, different specifications of the test regression include a constant, a constant and a trend, or neither of the two. The observation of the tests' p-values leads to reject the null hypothesis of a unit root in the residuals in most cases. In particular, the baseline test regression without constant, trend or country variables rejects the hypothesis of cointegration only in three cases for the baseline variables (total revenues in Italy and Spain and total expenditure in Spain) and in two cases for the additional variables (current revenue and direct taxes in Spain). Taking account of the potential presence of cointegration, the general specification for the estimated ECMs is given by the following expression

$$\Delta y_t = \alpha_1 \Delta u_t + \alpha_2 \left(y_{t-1} - \alpha_3 u_{t-1} \right) + \sum_j \omega^j \xi_t^j + v_t \qquad (1)$$

where y_t denotes the annual fiscal variable in ESA95 terms as a ratio to annual nominal GDP, u_t denotes the annual fiscal variable in cash accounts (sum of twelve consecutive months within the same year) as a ratio to annual nominal GDP, ξ_t^j is a set of dummy variables. [10]

In tables 4, 5 and 6 we present the results of the estimation of the Error Correction Models, along with relevant tests. Some general conclusions emerge.

[TABLE 4, TABLE 5, TABLE 6]

First, the Error Correction Models seem to capture some relevant features of the data. The goodness of fit R^2 varies, but it is in most cases reasonable in terms of the percentage of

[9] It is worth mentioning that ADF cointegration tests present some shortcomings linked to their lack of significance. Thus, even though the results in Table 3 tend to give a consistent picture of presence of cointegration they should be taken with caution.

[10] The choice of the dummies responds to the need to eliminate outliers and to take into account possible breaks in the definition of the series. A 1990 dummy is used to link the pre- and post-unification German variables. An impulse dummy variable in 1990 and another in 1991 for Belgium account for the exclusion of communities and regions in these years in the compilation of public accounts.

variance explained by the regression models (the R^2 is higher than 0.5 in 33 regressions on a total of 48), and the diagnostic tests generally show no remaining autocorrelation (LM1 test) or heteroskedasticity (White test) in the residuals. It is worth noticing that the regressions are run on changes of the variables as percent of GDP; the reported R^2 refers to the short run explanatory power of the ECM. The same models, if estimated in levels (percent of GDP) would have led to a R^2 much closer to 1. A better insight into the success of the cash figures in predicting the corresponding accrual data is provided by the results of the cointegration tests in table 3.

In addition, the percentage of correctly predicted changes (in sample) is included (denoted as "%correct" in the tables). This evidence assesses whether the rises and falls in the one-step forecast value match the actual rises and falls: the larger the percentage, the better the qualitative (directional) match. The reported figures are in all cases but one above 50%, in many cases remarkably so, thus showing that the fitted cash values of the ECM are informative about the direction of movement of the accrual-based data.

Second, the validity of the proposed indicators to be useful (leading) indicators has to be validated in view of their ability to anticipate the short-term developments of the national accounts variables. The coefficient α_1 measures the short-term link between both sets of variables, and it shows significant values in most cases, the only exceptions being revenue and expenditure for France and Spain, budget balance and expenditure for Greece and revenue for Finland. This conclusion is supported by the results of the F-test for the joint hypothesis of $\alpha_1=0$ and $\alpha_2=0$, i.e. a test for the influence of the indicator on the target variable.

Third, the validity for the proposed indicator variables to be useful (leading) indicators of the national accounts series is also related to the presence of a stable medium-term relationship between both sets of variables. The coefficient α_3 shows that the national accounts series for the deficit and the indicators are related, in most cases with a coefficient close to unity. [11] The coefficient α_3 departs from unity but remains significant for most of the other variables. Furthermore, a constant in the error correction vector appears to be often significant for revenue and expenditure, and never for the deficit. Our interpretation of these findings is that the mean discrepancies between the general government ESA95 data and the cash data on central governments as a percent of GDP cancel out when expenditure and revenues are subtracted from each other; in other words, most of the deficit is due to the central

[11] The tests for the individual significance of α_3 can be affected in the cases in which the null hypothesis H_0:$\alpha_2=0$ cannot be rejected. In this cases the results have to be taken with caution.

governments, and the local levels show a roughly balanced budget. Greece and Portugal are the exceptions with values for the estimated coefficients α_3 in the deficit equations that depart from unity (1.51 and 0.45, respectively) and statistically significant.

Fourth, in all cases the error correction term has the expected negative sign, implying the existence of an adjustment of the deviations from the long-term relationship. There is one sole exception which is total expenditure for Spain where α_2 is 0.086, albeit not significant. The results in term of statistical significance are less clear-cut, with the coefficient α_2 being statistically insignificant only in about 40% of cases, the worst performing series being those for Germany, Spain and Greece, while for Netherlands and Portugal α_2 is significant in all cases. For the additional variables, Germany and Italy always show a significant value for α_2, while for Spain this happens only in one case.

In summary, this section shows that: (i) the indicators and the corresponding ESA95 variables share long-term trends (cointegration); (ii) at the same time, there is valuable information in the short-term links between the indicators and the ESA95 variables that might be useful for short-term forecasting.

4. A State Space model

The purpose of this section is to develop a model that takes into account both sources of fiscal information simultaneously (i.e. annual ESA95 and monthly/quarterly Public Accounts) and that is at the same time consistent with the in-sample quantitative evidence and the Error Correction Models developed in the previous section.

Such a model may be built by assembling two different models: on the one hand the Error Correction Model at the annual frequency already discussed, and on the other hand some appropriate model for the intra-annual indicator variables. The system built in this way will allow for the generation of annual forecasts for the indicated fiscal variable as soon as any new observation about the intra-annual indicator variable becomes available. Without loss of generality the model will be specified at the quarterly frequency, as some indicators for some countries were only available at that frequency. When available, monthly information is transformed into the quarterly frequency by summation of the monthly information in the corresponding quarter.

Some technical problems have to be solved in order to set up such a system, mainly that the indicated and indicator time series are sampled at different time intervals (annual the indicated series, quarterly the indicator). This problem is solved in this paper by means of a State Space framework, which provides a convenient representation of dynamic systems in which this kind of problems may be solved in a relatively straightforward way, as illustrated below (see Harvey, 1989, and Pedregal and Young, 2002, for general references of State Space formulations).

The way the full model is built depends on the way the time series are defined. The indicated fiscal variables are defined as ratios to annual GDP. Thus, if these annual series are cast into a quarterly representation, the resulting time series would display missing values in the first three quarters of each year, and the observed annual ratio to GDP in the fourth quarter of each year. The quarterly indicator variables u_{qy} for quarter q of year y are defined in equation (2). [12]

$$u_{qy} = \frac{\sum_{i=1}^{q} Indicator_{iy}}{\sum_{i=1}^{q} GDP_{iy}} \times 100 \tag{2}$$

The variables so defined consists of registering at each quarter the cumulated value of the fiscal variable within each year as a ratio of cumulated GDP within that year expressed as a percentage. Thus, at the corresponding 4th quarter of each year the variable would display the ratio of the annual indicator (sum of the four quarters within each year) and annual GDP (sum of the four quarters within each year).

Building up the joint model for the indicated and the indicator variables implies three steps: (i) setting up the Error Correction Model at the annual frequency in a State Space framework; (ii) setting up the model for the indicator variable at the quarterly frequency; and (iii) setting up the joint model in a way that the output of the indicator model is incorporated as the input into the ECM equation.

The general State Space system is in the form of (3),

$$\begin{array}{ll} \textit{State equation:} & \mathbf{x}_{t+1} = \mathbf{\Phi x}_t + \mathbf{\Gamma u}_t + \mathbf{E w}_t \\ \textit{Observation equation:} & \mathbf{z}_t = \mathbf{H x}_t + \mathbf{D u}_t + \mathbf{v}_t \end{array} \tag{3}$$

[12] An alternative approach would be to use an accumulator variable that is a non linear combination of the GDP variable (see Camba-Méndez and Lamo, 2004).

where $\mathbf{z}_t$ is a m dimensional vector of observed endogenous variables for $t = 1,2,\ldots,N$; $\mathbf{x}_t$ is a n dimensional stochastic state vector; $\mathbf{u}_t$ is a r dimensional vector of deterministic exogenous variables; $\mathbf{w}_t$ and $\mathbf{v}_t$ are a k and m dimensional vectors of noises with constant covariance matrices $\mathbf{Q}$ and $\mathbf{R}$, respectively; and $\mathbf{\Phi}$, $\mathbf{\Gamma}$, $\mathbf{E}$, $\mathbf{H}$ and $\mathbf{D}$ are the system matrices.

4.1 The Error Correction Model in state space form

Equation (1) may be re-written as equation (4) with $a_1 = \alpha_1, a_2 = \alpha_2, a_3 = -\alpha_2\alpha_3$ and eliminating the exogenous dummy variables (that will be added later on),

$$\Delta y_t = a_1 \Delta u_t + a_2 y_{t-1} + a_3 u_{t-1} + v_t \tag{4}$$

A level specification of equation (4) is given in (5),

$$y_t = (1 + a_2) y_{t-1} + a_1 u_t + (a_3 - a_1) u_{t-1} + v_t \tag{5}$$

Casting (5) in the general State Space form (3) results in system (6) as a particular case, in which the output vector is just a scalar time series and both state and observation equations are affected by the same noise,

$$\begin{aligned} x_{t+1} &= (1 + a_2) x_t + [a_1 (1 + a_2) + (a_3 - a_1)] u_t + (1 + a_2) v_t \\ y_t &= x_t + a_1 u_t + v_t \end{aligned} \tag{6}$$

Notice that (6) is just the state space representation of the ECM model (1). In order to incorporate the model for the quarterly data, system (6) has to be re-arranged for that sampling interval. One possible expression that is exactly equivalent is given in equation (7), but now the time index is measured in quarters and the endogenous variable is arranged in a way such that the ratio variable for the year is located at the fourth quarter of that year and missing values are used to fill in the previous three quarters.

$$\begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}_{t+1} = \begin{bmatrix} 0 & 1 & 0 & 0 \\ 0 & 0 & 1 & 0 \\ 0 & 0 & 0 & 1 \\ 1 + a_2 & 0 & 0 & 0 \end{bmatrix} \begin{bmatrix} x_1 \\ x_2 \\ x_3 \\ x_4 \end{bmatrix}_t + \begin{bmatrix} 0 \\ 0 \\ 0 \\ a_1 (1 + a_2) + (a_3 - a_1) \end{bmatrix} u_t + \begin{bmatrix} 0 \\ 0 \\ 0 \\ (1 + a_2) \end{bmatrix} v_t \tag{7}$$

$$y_t = x_{1t} + a_1 u_t + v_t$$

System (7) may be written in compact form as (8), where the particular expression for each system matrix is obvious.

$$\begin{aligned} \mathbf{x}_{t+1} &= \mathbf{A}\mathbf{x}_t + \boldsymbol{\Gamma} u_t + \mathbf{E} v_t \\ y_t &= \mathbf{H}\mathbf{x}_t + a_1 u_t + v_t \end{aligned} \tag{8}$$

4.2 The model for the indicator variable

The quarterly indicator variable, defined according to equation (2) is modelled as a Basic Structural Model of Harvey (1989), [13] which decomposes a time series into trend, seasonal and irregular component. This model is directly set up in State Space form and the expression is well-known. Equation (9) provides the system in compact form (see details in Harvey, 1989).

$$\begin{aligned} \mathbf{x}^u_{t+1} &= \boldsymbol{\Phi}\mathbf{x}^u_t + \mathbf{E}^u \mathbf{w}_t \\ u_t &= \mathbf{H}^u \mathbf{x}^u_t + v^u_t \end{aligned} \tag{9}$$

where the indicator series u_t are decomposed into a vector $\mathbf{x}^u_t$, that contains a trend component and a seasonal component, and a vector v^u_t of irregular components.

4.3 Joint model

Systems (8) and (9) are then the two models written in State Space form of both the indicated and indicator variables with the same sampling interval. The joint model is then built by substituting the observation equation of (9) into (8). The resulting system is given in equation (10).

$$\begin{aligned} \mathbf{x}_{t+1} &= \mathbf{A}\mathbf{x}_t + \boldsymbol{\Gamma}\left[\mathbf{H}^u \mathbf{x}^u_t + v^u_t\right] + \mathbf{E} v_t \\ y_t &= \mathbf{H}\mathbf{x}_t + a_1\left[\mathbf{H}^u \mathbf{x}^u_t + v^u_t\right] + v_t \end{aligned} \tag{10}$$

Equation (10) may be re-arranged in order to write it in State Space form in a way such that the original exogenous variable (i.e. the indicator) is converted into an endogenous variable

[13] Alternative models could be incorporated easily in the formulation that follows. For some variables it could be the case that another formulation (for example, an ARIMA model) would present better forecasting properties (see Pérez, 2007, in this respect). We sidestep this issue in the remainder of the paper and keep the issue of finding the model for the quarterly indicators with the best *univariate* forecasting properties for further research.

$$
\begin{bmatrix} \mathbf{x}_{t+1} \\ \mathbf{x}^u_{t+1} \end{bmatrix} = \begin{bmatrix} \mathbf{A} & \mathbf{\Gamma H}^u \\ \mathbf{0} & \mathbf{\Phi} \end{bmatrix} \begin{bmatrix} \mathbf{x}_t \\ \mathbf{x}^u_t \end{bmatrix} + \begin{bmatrix} \mathbf{E} & \mathbf{\Gamma} & \mathbf{0} \\ \mathbf{0} & \mathbf{0} & \mathbf{E}^u \end{bmatrix} \begin{bmatrix} v_t \\ v^u_t \\ \mathbf{w}_t \end{bmatrix}
$$

$$
\begin{bmatrix} y_t \\ u_t \end{bmatrix} \begin{bmatrix} \mathbf{H} & a_1\mathbf{H}^u \\ \mathbf{0} & \mathbf{H}^u \end{bmatrix} \begin{bmatrix} \mathbf{x}_t \\ \mathbf{x}^u_t \end{bmatrix} + \begin{bmatrix} 1 & a_1 \\ \mathbf{0} & 1 \end{bmatrix} \begin{bmatrix} v_t \\ v^u_t \end{bmatrix} + \begin{bmatrix} \mathbf{D} \\ \mathbf{D}^u \end{bmatrix} \begin{bmatrix} \mathbf{I}_t \\ \mathbf{I}^u_t \end{bmatrix} \tag{11}
$$

The last term included in the observation equation allows for the introduction of dummy variables in the model in order to deal with outliers intervention in either of the output (annual) or the input (quarterly) variables.

Table 7 shows some typical statistics of the innovations processes obtained from the estimation of model (11) for all the selected variables and countries. We show the statistics for the innovations corresponding to the ECM equation. Q(6) is the Ljung-Box pormanteau test of autocorrelation and Jarque-Bera is a normality test based on a Chi Squared distribution with two degrees of freedom. [14] There are only four cases of possible innovations autocorrelation suggested by high values of the Q(6) statistic. Normality cannot be rejected in any of the cases, judging by the Jarque-Bera test.

[TABLE 7]

5. Forecasting performance exercise

5.1 Design of the forecast exercise

For the out-of-sample exercise we consider the exercise, common in international organisations, of forecasting the current year and one year ahead outcomes. The forecasting window 1994-2006 was selected to guarantee enough data points for the estimation of the shortest sample model (Spain, with a sample of quarterly data covering 1984-1993). The current year forecasts are those produced using information up to quarter *t* of a given year *T* for the same year *T*. One year ahead forecasts are those produced using information up to quarter *t* of year *T*, for year *T+1*. The forecast errors incurred with forecasting method *m* would be:

[14] All models are estimated with the MATLAB toolbox of Pedregal (2004)

Current year: $\varepsilon^{m}_{T/\Omega_{T,t}} = X_T - \hat{X}^{m}_{T/\Omega_{T,t}}$

One year ahead: $\varepsilon^{m}_{T+1/\Omega_{T,t}} = X_{T+1} - \hat{X}^{m}_{T+1/\Omega_{T,t}}$

The information set $\Omega_{T,t}$ at each point in time would encompass all annual and quarterly information available up to that point. We present the results for the whole set of forecasts (i.e. for all the years and quarters in the information set), and also for forecasts made with information up to the first and the second quarters of a given year T in order to get insights into two issues: (i) is the information available for the first half of the year informative enough as to the evolution of the whole year?; (ii) is there a gain in forecast accuracy when information for he second half of the year is included?

As regards the timing of the information included, our forecasting exercise aims at capturing the real-time information constraints faced by a forecaster by considering the following rules: (i) the quarterly figure available in a given quarter j is the one corresponding to the previous observed quarter $j-1$, to reflect the fact that cash indicators are usually collected with a delay on 1-2 months; (ii) the annual figure for year $t-1$ is available in the second quarter of year t, following the Spring Excessive Deficit Procedure (EDP) Notification of fiscal data from EU Member States to Eurostat. [15]

It is worth noticing that all the forecasts are produced for the ratios of fiscal variables to GDP, and therefore forecast errors will be a mixture of errors linked to fiscal variables (numerator) and GDP (denominator), but could also possibly profit from co-movements between numerators and denominators. This choice is dictated by the consolidated practice to assess the fiscal variables on the basis of their ratios to GDP.

5.2 Alternative methods

In order to check the performance of our proposed mixed-frequency model, we considered the following forecasting methods:

(i) Our mixed-frequency model (MIX hereafter) as defined in equation (11).

(ii) A standard bridge equation approach whereby, first, a univariate model is fitted to the quarterly figures (equation 9) and, second, an ECM in the vein of (7) is run. This method (2ST hereafter) amounts at doing in two separate steps what MIX does in one go.

[15] Spring EDP fiscal data for year $t-1$ are usually available by April of each year t.

(iii) An annual autoregressive model of order 1 (AR1 hereafter).

(iv) A naïve annual random walk forecast (ARW hereafter).

5.3 Out-of-sample forecasting performance measures

We illustrate the relative performance of our method compared to the alternatives by means of two standard measures of quantitative forecast performance: Root Mean Squared Errors (RMSE) and the Diebold-Mariano test (Diebold and Mariano, 1995).

We compare the ratio of the RMSE of the different alternatives with respect to the ARW alternative. The RMSEs for method *m* for current year projections and the one-year ahead projections are defined as

$$RMSE^{m}_{\substack{current\\ year}} = \sqrt{\sum_{T=1994}^{2006}\sum_{t=1}^{4}\left(\varepsilon^{m}_{T/\Omega_{T,t}}\right)^{2}} = \sqrt{\sum_{T=1994}^{2006}\sum_{t=1}^{4}\left(X_{T}-\hat{X}^{m}_{T/\Omega_{T,t}}\right)^{2}}$$

$$RMSE^{m}_{\substack{one\ year\\ ahead}} = \sqrt{\sum_{T=1994}^{2005}\sum_{t=1}^{4}\left(\varepsilon^{m}_{T+1/\Omega_{T,t}}\right)^{2}} = \sqrt{\sum_{T=1994}^{2005}\sum_{t=1}^{4}\left(X_{T+1}-\hat{X}^{m}_{T+1/\Omega_{T,t}}\right)^{2}}$$

Notice that there are four forecasts available per year, which makes up to a total of 52 and 48 forecast errors in the cases of the current year and the one-year-ahead cases respectively.

We have also included the Diebold and Mariano test (DM), given concerns in the literature that the ratio of RMSEs, being a deterministic criterion, might be misleading as it could be the case that some differences in RMSEs between methods may not be significant from a statistical point of view. DM test for the null hypothesis of no difference in the accuracy of two competing forecasts. Consider the time series of forecast errors $\{\varepsilon^{m}_{n}\}^{N}_{n=1}$. The idea of the test is to assess the expected loss associated with each of the forecasts (or its inverse, accuracy). Let the time-*n* loss associated with a forecast generated with alternative *m* be an arbitrary function of the realization and prediction $g(\varepsilon^{m}_{n})$. The null hypothesis of equal forecast accuracy for two forecasts *m* and *m'* is $E\left(g(\varepsilon^{m}_{n})\right)=E\left(g(\varepsilon^{m'}_{n})\right)$ or $E\left(d^{m,m'}_{n}\right)=0$ where $d^{m,m'}_{n} \equiv g(\varepsilon^{m}_{n})-g(\varepsilon^{m'}_{n})$ is the loss differential. Thus, the *equal accuracy* null hypothesis is equivalent to the null hypothesis that the population mean of the loss differential series is 0. Regarding the loss function specification, we take the standard quadratic loss $g(\varepsilon)=\varepsilon^{2}$. In order to minimize the possible bias arising from ignoring parameter uncertainty we make sure that a reasonable proportion of the sample is employed when the first out of sample forecast is computed (the forecast exercise is performed on the moving window 1994-2006 while the full sample covers 1970-2006).

5.4 Discussion of the results

Tables 8 and 9 present the RMSE ratios for all countries. The reading of the ratios is the following. A ratio of unity or higher indicates that the MIX, 2ST and AR1 forecasts are as good or worse than the ARW forecasts, while a ratio below unity signals that the ARW is worse. Several salient features are worth mentioning: (i) the MIX and 2ST alternatives (methods with intra-annual update) outperform the annual ARW and AR1 alternatives; (ii) the MIX and 2ST alternatives behave quite similarly, although MIX presents somewhat better performance records; (iii) there seems to be an efficient use of the quarterly information, as the case in which all quarters are used always presents a better performance than the case in which only information for the first half of the year is used; (iv) at the same time, the forecasts for the whole current year with information up to the second quarter tend to present a reasonably accurate record; (v) one year ahead forecasts present a reasonable accuracy record in the case of MIX and 2ST compared to ARW and AR1.

[TABLE 8, TABLE 9]

Tables 10, 11 and 12 show the results of the DM test. The number in each cell represents the loss differential of the method in its vertical column as compared to the method in the horizontal line, i.e. a negative value means that the loss associated to the method in the horizontal line is higher than that of the method in the vertical column. The results tend to confirm all the findings mentioned before: MIX and 2ST are better than ARW and AR1, there seems to be an efficient use of quarterly information, and the quarterly information pertaining to the first half of the year presents a reasonable accuracy record. In addition, current year MIX forecasts are not distinguishable from 2ST in most cases. Minor exceptions in which MIX dominates 2ST are (at the 5% significance level) the deficit in Netherlands and Austria, and total revenue in Belgium, Germany and Netherlands, while 2ST dominates in the cases of total revenue and total expenditure in Austria. With quite a few exceptions, one year ahead forecasts of MIX and 2ST are indistinguishable as well.

[TABLE 10, TABLE 11, TABLE 12]

Finally, Table 13 compares the forecasts generated with each method (MIX, 2ST, AR1, ARW) of the deficit based on the deficit indicator and the deficit based on the difference between forecasted revenues and expenditures. Both the RMSE and the Diebold-Mariano test are presented. The information presented supports the fact that there is no gain in preparing disaggregated forecasts of revenues and expenditures *if* the final aim were to obtain a forecast of the government deficit as a ratio to GDP, but that the differences in accuracy are not too strong, and thus the researcher/practitioner would not loss too much accuracy if it were to follow the disaggregated approach.

When we consider the ratios of the RMSEs to ARW generated with both alternatives (disaggregated and direct forecast), in an overwhelming majority of the cases (18 out of 24 cases) the ratio is lower in the case of the direct forecast approach. In line with this result, most of the DM-losses presented in the last column of Table 12 are positive (18 out of 24 cases, as expected), but the differences are only significant from a statistical point of view for the MIX and 2ST methods in the cases of Belgium, Spain and Finland. For the other countries analysed (Germany, France, Italy, Netherlands and Austria) the differences are not significant from a statistical point of view.

[TABLE 13]

6. Conclusions

This paper makes a contribution to the recent literature analysing the usefulness of intra-year fiscal data for monitoring and forecasting annual ESA95 fiscal variables.

On the data coverage the contribution of our paper lies in moving the literature beyond fiscal deficit series, and use a wide set of public accounts (cash) indicators. For the in-sample predictive exercise up to a total of 50 revenue and expenditure items (comprising indicators for Belgium, Germany, Spain, France, Greece, Italy, Netherlands, Austria, Portugal and Finland) are used, while in the out-of-sample exercise we focus on government deficit, total revenue and total expenditure for 8 euro area countries (the previous list excluding Greece and Portugal). On the methodological side, our contribution consist of estimating mixed-frequency state-space models that integrate an error correction structure linking fiscal indicators to annual target variables together with structural time series models for the indicator variables. Thus, we are able to integrate in a joint model readily available monthly and quarterly cash data with annual general government series.

We show in-sample and out-of-sample evidence supporting the view that intra-annual fiscal information contains valuable information for monitoring and forecasting annual fiscal aggregates. In addition, we show that the estimated mixed-frequency state-space models tend to present a better forecast record than a 2-steps (bridge equation) approach. Nevertheless, the overall forecast performance of both approaches is quite similar. In this respect, the main advantage of the mixed-frequencies models presented in the paper, as compared to bridge equation alternatives, lies in the gains of efficiency derived from the joint estimation of the models, and the fact that we present a ready-to-use companion toolbox. Finally, we provide some evidence showing that models that directly forecast the government deficit tend to outperform disaggregated deficit forecasts whereby the deficit is computed as the difference between projected revenues and expenditures.

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Figure 1. ESA95 (solid) and selected indicator (solid-dotted) series

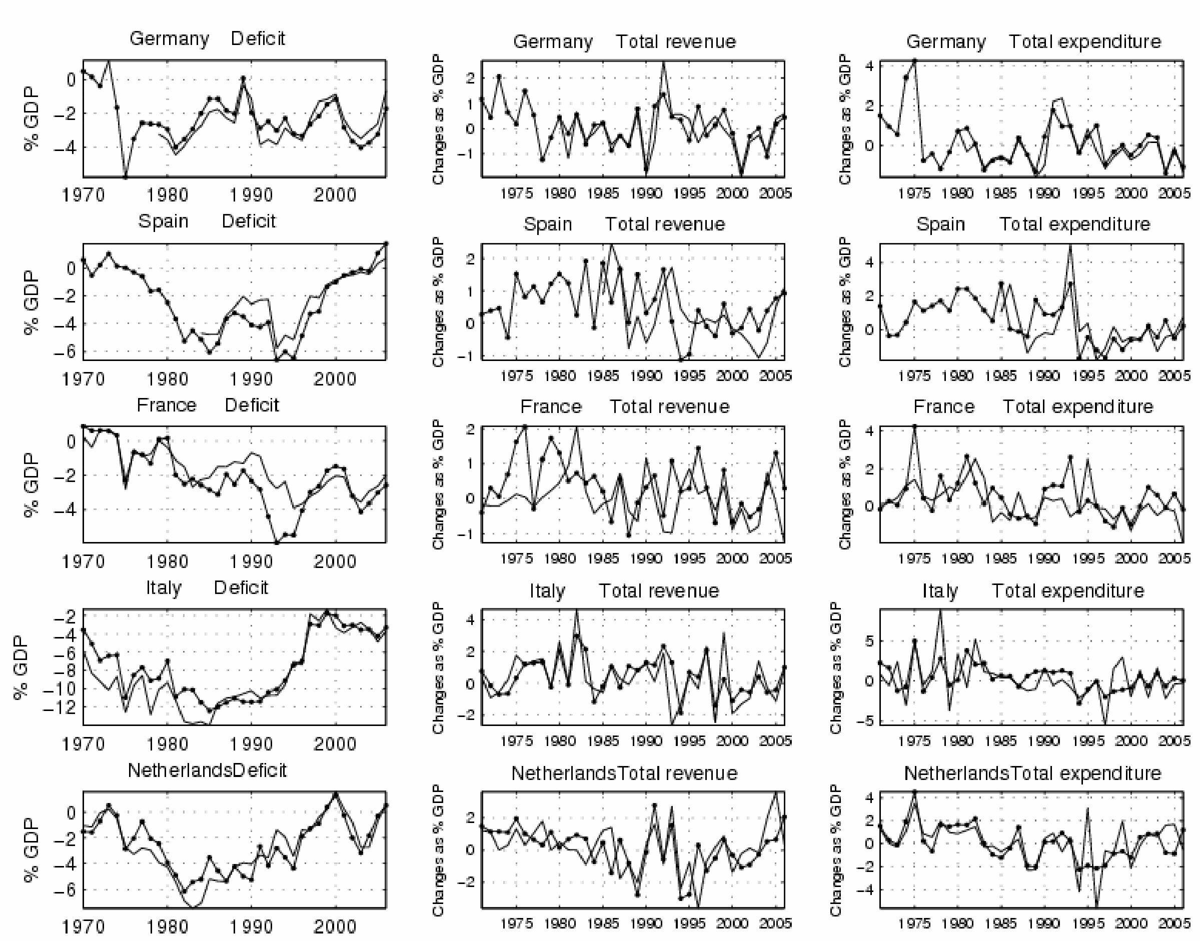

Table 1. Description and sources: indicator series.

Country	Indicator	Sector	Sample	Source
Baseline variables				
Belgium	Deficit Total Revenue Total Expenditure	Federal Govt., communities and regions (until 1991), Federal Govt. (from 1992)	Jan. 1963 - Dec. 2006	National Bank of Belgium
Germany	Deficit Total Revenue Total Expenditure	General Government (Public accounts)	1979 Q1 - 2006 Q4	Deutsche Bundesbank
Spain	Deficit Total Expenditure Total Revenue	Central Government (ESA95)	Jan. 1984 - Dec. 2006	INE (National Statistical Institute
France	Deficit Total Revenue Total Expenditure	Central Government	Jan. 1964 - Dec. 2006	Ministry of Finance
Greece	Deficit Total Revenue Total Expenditure	Central Government	Jan. 1980 - Dec. 2006	National Bank of Greece
Italy	Deficit Total Revenue Total Expenditure	Central Government	Dec. 1984 - Dec. 2006 Jan. 1960 - Dec. 2006	Banca d'Italia
Netherlands	Deficit Total Revenue Total Expenditure	Central Government	Jan. 1968 - Dec. 2006 Jan. 1968 - Jan. 2006	IFS from IMF
Austria	Deficit Total Revenue Total Expenditure	Central Government	Jan. 1971 - Dec. 2006	National Bank of Austria
Portugal	Deficit Total Revenue Total Expenditure	Central Government	Jan. 1997 - Dec. 2006	General Accounting Office
Finland	Deficit Total Expenditure Total Revenue	Central Government	Jan. 1967 - Dec. 2006	National Bank of Finland
Additional variables				
Belgium	DirectTaxes Indirect Taxes		Jan. 1970 - Feb 2006	National Bank of Belgium
Germany	Deficit Total Revenue Total Expenditure Tax Revenue Direct Taxes Intirect Taxes Compensation of Employees Consumption Expenditure	Federal Government	Jan. 1970 - Dec. 2006	Federal Ministry of Finance
Spain	Current Revenue Direct Taxes Indirect Taxes Current Expenditure Intermediate Consumption Compensation of Employees Social Payments	Central Government	Jan. 1984 - Dec. 2006	INE (National Statistical Institute
Italy	Current Expenditure Tax Revenue	General Government	Jan. 1986 - Dec. 2006	Banca d'Italia

Table 2. Unit Root tests: (H_0: y_t has a unit root)

		ESA 95 annual variables				Cash indicators (annualised)			
		Exogenous variables:				*Exogenous variables:*			
		Constant		Constant, Trend		Constant		Constant, Trend	
		Lag Length	p-value	*Lag Length*	p-value	*Lag Length*	p-value	*Lag Length*	p-value
Baseline variables									
Belgium	Deficit	*0*	0.733	*0*	0.599	*1*	0.630	*1*	0.589
	Total Revenue	*0*	0.110	*0*	0.561	*2*	0.075	*0*	0.761
	Total Expenditure	*2*	0.223	*2*	0.494	*1*	0.214	*1*	0.464
Germany	Deficit	*0*	0.017	*0*	0.088	*1*	0.063	*1*	0.120
	Total Revenue	*0*	0.009	*0*	0.135	*0*	0.204	*0*	0.737
	Total Expenditure	*1*	0.015	*1*	0.115	*0*	0.346	*0*	0.819
Spain	Deficit	*0*	0.770	*0*	0.974	*0*	0.751	*0*	0.671
	Total Revenue	*0*	0.334	*0*	0.978	*1*	0.035	*1*	0.102
	Total Expenditure	*0*	0.130	*0*	0.995	*0*	0.251	*0*	0.665
France	Deficit	*1*	0.179	*1*	0.332	*0*	0.102	*0*	0.053
	Total Revenue	*0*	0.311	*0*	0.884	*0*	0.666	*0*	0.980
	Total Expenditure	*8*	0.002	*5*	0.953	*0*	0.132	*0*	0.994
Greece	Deficit	*0*	0.280	*0*	0.803	*0*	0.438	*0*	0.965
	Total Revenue	*0*	0.854	*0*	0.890	*0*	0.940	*0*	0.652
	Total Expenditure	*0*	0.478	*0*	0.988	*0*	0.436	*7*	0.014
Italy	Deficit	*0*	0.600	*0*	0.448	*0*	0.375	*0*	0.635
	Total Revenue	*0*	0.630	*0*	0.959	*1*	0.242	*1*	0.998
	Total Expenditure	*1*	0.269	*0*	0.936	*0*	0.260	*0*	0.965
Netherlands	Deficit	*0*	0.428	*0*	0.685	*0*	0.710	*1*	0.534
	Total Revenue	*0*	0.224	*0*	0.271	*0*	0.774	*0*	0.845
	Total Expenditure	*1*	0.463	*1*	0.577	*0*	0.873	*2*	0.498
Austria	Deficit	*0*	0.140	*0*	0.501	*0*	0.350	*0*	0.607
	Total Revenue	*0*	0.036	*0*	0.905	*0*	0.029	*0*	0.873
	Total Expenditure	*0*	0.055	*0*	0.904	*1*	0.071	*0*	0.845
Portugal	Deficit	*0*	0.048	*0*	0.249	*0*	0.078	*0*	0.338
	Total Revenue	*2*	0.714	*0*	0.178	*0*	0.793	*0*	0.366
	Total Expenditure	*0*	0.229	*0*	0.773	*0*	0.227	*1*	0.441
Finland	Deficit	*1*	0.150	*1*	0.339	*1*	0.029	*1*	0.111
	Total Revenue	*0*	0.138	*0*	0.860	*0*	0.305	*0*	0.440
	Total Expenditure	*1*	0.250	*1*	0.563	*1*	0.151	*1*	0.282
Additional variables									
Belgium	Indirect Taxes	*0*	0.792	*0*	0.233	*0*	0.552	*0*	0.139
	Direct Taxes	*0*	0.011	*0*	0.273	*0*	0.010	*0*	0.341
Germany	Deficit	-	-	-	-	*0*	0.007	*0*	0.046
	Total Revenue	-	-	-	-	*0*	0.558	*0*	0.101
	Total Expenditure	-	-	-	-	*0*	0.519	*0*	0.103
	Tax Revenue	*0*	0.007	*0*	0.144	*0*	0.820	*1*	0.035
	Direct Taxes	*0*	0.251	*0*	0.036	*0*	0.000	*6*	0.000
	Intirect Taxes	*0*	0.281	*0*	0.794	*8*	0.000	*0*	0.000
	Compensation of Employees	*2*	0.871	*1*	0.033	*0*	0.996	*0*	0.001
	Consumption Expenditure	*1*	0.021	*1*	0.124	*0*	0.567	*0*	0.352
Spain	Current Revenue	*0*	0.328	*0*	0.976	*1*	0.220	*4*	0.249
	Direct Taxes	*0*	0.584	*0*	0.918	*0*	0.192	*0*	0.519
	Indirect Taxes	*0*	0.959	*0*	0.554	*0*	0.579	*0*	0.325
	Current Expenditure	*1*	0.335	*1*	0.963	*1*	0.757	*1*	0.574
	Intermediate Consumption	*0*	0.765	*1*	0.412	*1*	0.705	*1*	0.629
	Compensation of Employees	*1*	0.232	*0*	0.994	*3*	0.982	*3*	0.867
	Social Payments	*0*	0.117	*0*	0.913	*2*	0.937	*2*	0.922
Italy	Tax Revenue	*0*	0.619	*0*	0.961	*0*	0.075	*0*	0.248
	Current Expenditure	*1*	0.346	*0*	0.927	*0*	0.582	*0*	0.254

Notes:

(i) Estimated equation: $\Delta y_t = \rho y_{t-1} + \sum_{j=1}^{J} \rho_j y_{t-j} + \varepsilon_t$.

(ii) MacKinnon (1996) critical values are used in constructing the test output.
(iii) Lag length J selected using a SIC criteria.

Table 3. Cointegration tests: ADF tests on the residuals (H_0: v_t has a unit root)

Estimated equation: $\Delta\hat{v}_t = \lambda_0 + \lambda_1 trend_t + \lambda_2 \hat{v}_{t-1} + \sum \lambda_i \Delta\hat{v}_{t-i} + \varepsilon_t$ *, v obtained by OLS from* $\Delta y_t = \alpha_1 \Delta u_t + \alpha_2 (y_{t-1} - \alpha_3 u_{t-1})$ $+ \sum \omega^j \xi_{t,j} + v_t$ *, (y ESA95 annual fiscal variable, u annual fiscal variable in cash accounts both as a ratio to annual nominal GDP,* ξ *is a set of dummy variables).*

		No exogenous variable		Constant		Constant, Trend	
		Lag Length	p-value	*Lag Length*	p-value	Lag Length	p-value
Baseline variables							
Belgium	Deficit	*0*	0.000	*0*	0.002	*0*	0.009
	Total Revenue	*0*	0.000	*0*	0.004	*0*	0.032
	Total Expenditure	*0*	0.007	*0*	0.068	*0*	0.812
Germany	Deficit	*0*	0.011	*0*	0.114	*0*	0.032
	Total Revenue	*1*	0.033	*1*	0.235	*0*	0.011
	Total Expenditure	*0*	0.010	*0*	0.106	*0*	0.079
Spain	Deficit	*0*	0.039	*0*	0.272	*0*	0.469
	Total Revenue	*1*	0.255	*0*	0.108	*1*	0.697
	Total Expenditure	*1*	0.131	*2*	0.023	*1*	0.769
France	Deficit	*0*	0.000	*0*	0.001	*0*	0.008
	Total Revenue	*0*	0.048	*0*	0.305	*0*	0.868
	Total Expenditure	*4*	0.038	*4*	0.023	*4*	0.763
Greece	Deficit	*0*	0.053	*0*	0.331	*0*	0.434
	Total Revenue	*0*	0.000	*0*	0.009	*0*	0.024
	Total Expenditure	*0*	0.003	*0*	0.038	*0*	0.063
Italy	Deficit	*0*	0.000	*0*	0.006	*0*	0.024
	Total Revenue	*0*	0.163	*0*	0.611	*0*	0.639
	Total Expenditure	*0*	0.071	*0*	0.402	*0*	0.313
Netherlands	Deficit	*0*	0.002	*0*	0.028	*0*	0.105
	Total Revenue	*0*	0.006	*0*	0.069	*0*	0.166
	Total Expenditure	*0*	0.002	*0*	0.023	*0*	0.105
Austria	Deficit	*0*	0.032	*0*	0.236	*0*	0.307
	Total Revenue	*0*	0.003	*0*	0.038	*0*	0.252
	Total Expenditure	*0*	0.047	*0*	0.304	*0*	0.211
Portugal	Deficit	*0*	0.001	*0*	0.019	*0*	0.084
	Total Revenue	*0*	0.027	*0*	0.233	*0*	0.317
	Total Expenditure	*0*	0.030	*0*	0.244	*0*	0.371
Finland	Deficit	*0*	0.009	*0*	0.095	*0*	0.038
	Total Revenue	*0*	0.008	*0*	0.085	*0*	0.288
	Total Expenditure	*0*	0.033	*0*	0.249	*1*	0.076
Additional variables							
Belgium	Indirect Taxes	*0*	0.000	*0*	0.000	*0*	0.001
	Direct Taxes	*0*	0.016	*0*	0.148	*0*	0.133
Germany	Deficit	*0*	0.000	*0*	0.001	*0*	0.001
	Total Revenue	*0*	0.001	*0*	0.020	*0*	0.127
	Total Expenditure	*0*	0.001	*0*	0.017	*0*	0.211
	Tax Revenue	*0*	0.001	*0*	0.020	*0*	0.111
	Direct Taxes	*0*	0.004	*0*	0.046	*0*	0.161
	Intirect Taxes	*0*	0.043	*0*	0.285	*0*	0.785
	Compensation of Employees	*1*	0.002	*1*	0.026	*1*	0.105
	Consumption Expenditure	*2*	0.000	*2*	0.000	*2*	0.000
Spain	Current Revenue	*1*	0.166	*1*	0.531	*1*	0.635
	Direct Taxes	*1*	0.327	*1*	0.815	*1*	0.678
	Indirect Taxes	*0*	0.005	*0*	0.061	*0*	0.073
	Current Expenditure	*1*	0.037	*1*	0.261	*1*	0.491
	Intermediate Consumption	*1*	0.046	*0*	0.745	*1*	0.575
	Compensation of Employees	*3*	0.014	*3*	0.113	*3*	0.449
	Social Payments	*1*	0.014	*1*	0.136	*1*	0.294
Italy	Deficit	*0*	0.002	*0*	0.030	*0*	0.101
	Tax Revenue	*0*	0.000	*0*	0.007	*0*	0.012
	Current Expenditure	*0*	0.070	*0*	0.390	*0*	0.744

Notes:
(i) MacKinnon (1996) critical values are used in constructing the test output.
(ii) Lag length J selected using a SIC criteria.

Table 4. Error correction models (I): baseline variables (as defined in Table 1).

Estimated equation: $\Delta y_t = \alpha_1 \Delta u_t + \alpha_2 (y_{t-1} - \alpha_3 u_{t-1}) + \Sigma \omega^j \xi_{t,j} + v_t$, *(y ESA95 annual fiscal variable, u annual fiscal variable in cash accounts both as a ratio to annual nominal GDP, ξ is a set of dummy variables).*

Country	Dependent Variable	*Sample*	Short-term coefficient α_1	Error correction coefficient α_2	Long-term coefficient α_3	Goodness of fit statistics	In-sample tests of predictability	Dummy variables
Belgium	**Deficit**	*1971–2006*	1.002 (0.188)	-0.551 (0.170)	-0.880 (0.093)	R-sq = 0.56 LM(1) (pval) = 0.711 White Test (pval) = 0.001	F-test (pval) = 0.000 % correct = 0.743	Impulse 1980
	Total Revenue	*1971–2006*	0.252 (0.106)	-0.086 (0.068)	-0.221 (0.315)	R-sq = 0.41 LM(1) (pval) = 0.040 White Test (pval) = 0.730	F-test (pval) = 0.018 % correct = 0.571	Impulse 1989
	Total Expenditure	*1971–2006*	0.568 (0.122)	-0.860 (0.184)	-0.514 (0.032)	R-sq = 0.54 LM(1) (pval) = 0.043 White Test (pval) = 0.121	F-test (pval) = 0.000 % correct = 0.714	
Germany	**Deficit**	*1980–2006*	0.885 (0.056)	-0.084 (0.090)	-1.217 (0.428)	R-sq = 0.92 LM(1) (pval) = 0.892 White Test (pval) = 0.215	F-test (pval) = 0.000 % correct = 0.923	Impulse 1990
	Total Revenue	*1980–2006*	0.321 (0.090)	-0.143 (0.110)	-0.309 (0.278)	R-sq = 0.67 LM(1) (pval) = 0.689 White Test (pval) = 0.906	F-test (pval) = 0.002 % correct = 0.577	Impulse 1990 Impulse 2001
	Total Expenditure	*1980–2006*	0.457 (0.108)	-0.090 (0.111)	-0.489 (0.638)	R-sq = 0.49 LM(1) (pval) = 0.753 White Test (pval) = 0.841	F-test (pval) = 0.001 % correct = 0.615	Impulse 1990 Impulse 2001
Spain	**Deficit**	*1985–2006*	0.959 (0.130)	-0.104 (0.173)	-1.148 (0.632)	R-sq = 0.78 LM(1) (pval) = 0.193 White Test (pval) = 0.263	F-test (pval) = 0.000 % correct = 0.810	
	Total Revenue	*1985–2006*	0.101 (0.184)	-0.071 (0.099)	2.566 (4.906)	R-sq = 0.57 LM(1) (pval) = 0.351 White Test (pval) = 0.337	F-test (pval) = 0.720 % correct = 0.667	Impulse 1992
	Total Expenditure	*1985–2006*	0.220 (0.158)	0.086 (0.118)	-4.545 (4.962)	R-sq = 0.69 LM(1) (pval) = 0.518 White Test (pval) = 0.017	F-test (pval) = 0.076 % correct = 0.857	Impulse 1988
France	**Deficit**	*1971–2006*	0.750 (0.158)	-0.248 (0.130)	-0.793 (0.478)	R-sq = 0.51 LM(1) (pval) = 0.773 White Test (pval) = 0.688	F-test (pval) = 0.000 % correct = 0.714	
	Total Revenue	*1980–2006*	0.186 (0.182)	-0.083 (0.082)	1.774 (2.306)	R-sq = 0.26 LM(1) (pval) = 0.620 White Test (pval) = 0.863	F-test (pval) = 0.187 % correct = 0.657	
	Total Expenditure	*1980–2006*	0.143 (0.184)	-0.092 (0.093)	1.839 (3.227)	R-sq = 0.35 LM(1) (pval) = 0.345 White Test (pval) = 0.944	F-test (pval) = 0.440 % correct = 0.629	
Greece	**Deficit**	*1971–2006*	0.602 (0.650)	-0.105 (0.090)	1.513 (2.798)	R-sq = 0.45 LM(1) (pval) = 0.384 White Test (pval) = 0.001	F-test (pval) = 0.421 % correct = 0.543	Impulse 1981 Impulse 1993
	Total Revenue	*1971–2006*	2.254 (0.714)	-0.105 (0.183)	-3.565 (0.776)	R-sq = 0.40 LM(1) (pval) = 0.054 White Test (pval) = 0.261	F-test (pval) = 0.005 % correct = 0.629	Impulse 2001
	Total Expenditure	*1971–2006*	0.018 (0.540)	-0.105 (0.095)	-1.286 (1.249)	R-sq = 0.25 LM(1) (pval) = 0.841 White Test (pval) = 0.012	F-test (pval) = 0.529 % correct = 0.571	Impulse 1990

Notes:
(i) Figures in parenthesis below estimates are standard errors of the estimated coefficients;

(ii) Diagnosis measures: (1) R-sq: coefficient of determination; (2) LM(1): Breusch-Godfrey Lagrange Multiplier test for serial correlation in the residuals (null hypothesis of no serial correlation in the residuals up to specified lag order); (3) White test (White, 1980): test for heteroskedasticity in the residuals (null hypothesis of no heteroskedasticity against heteroskedasticity of unknown form); (4) F-test: Wald test for null hypothesis that $\alpha_1 = \alpha_2 = 0$.

(iii) Dummy variables: (1) Impulse: equals 1 in date t and zero elsewhere; (2) Impulse 83/84: equals 1 in 1983, -1 in 1984, and zero elsewhere.*

Table 5. Error correction models (II): baseline variables (as defined in Table 1).

Estimated equation: $\Delta y_t = \alpha_1 \Delta u_t + \alpha_2 \left(y_{t-1} - \alpha_3 u_{t-1} \right) + \sum \omega^j \xi_{t,j} + v_t$, *(y ESA95 annual fiscal variable, u annual fiscal variable in cash accounts both as a ratio to annual nominal GDP, ξ is a set of dummy variables).*

Country	Dependent Variable	*Sample*	Short-term coefficient α_1	Error correction coefficient α_2	Long-term coefficient α_3	Goodness of fit statistics	In-sample tests of predictability	Dummy variables
Italy	**Deficit**	*1971–2006*	0.654 (0.105)	-0.020 (0.088)	-0.826 (2.072)	R-sq = 0.77 LM(1) (pval) = 0.486 White Test (pval) = 0.970	F-test (pval) = 0.000 % correct = 0.686	Impulse 1975 Impulse 1981
	Total Revenue	*1971–2006*	0.499 (0.093)	-0.404 (0.135)	-0.741 (0.038)	R-sq = 0.58 LM(1) (pval) = 0.041 White Test (pval) = 0.070	F-test (pval) = 0.000 % correct = 0.687	Impulse 83/84*
	Total Expenditure	*1971–2006*	0.261 (0.108)	-0.104 (0.108)	-0.254 (0.470)	R-sq = 0.46 LM(1) (pval) = 0.070 White Test (pval) = 0.933	F-test (pval) = 0.070 % correct = 0.800	Impulse 1975
Netherlands	**Deficit**	*1971–2006*	0.788 (0.101)	-0.295 (0.123)	-0.777 (0.104)	R-sq = 0.69 LM(1) (pval) = 0.800 White Test (pval) = 0.268	F-test (pval) = 0.000 % correct = 0771	
	Total Revenue	*1971–2006*	0.285 (0.124)	-0.139 (0.057)	-0.980 (0.371)	R-sq = 0.55 LM(1) (pval) = 0.504 White Test (pval) = 0.110	F-test (pval) = 0.001 % correct = 0.714	Impulse 1986 Impulse 1994
	Total Expenditure	*1971–2006*	0.355 (0.107)	-0.093 (0.042)	-1.219 (0.447)	R-sq = 0.66 LM(1) (pval) = 0.299 White Test (pval) = 0.457	F-test (pval) = 0.000 % correct = 0.714	Impulse 1975
Austria	**Deficit**	*1971–2006*	1.240 (0.155)	-0.165 (0.106)	-0.910 (0.209)	R-sq = 0.73 LM(1) (pval) = 0.018 White Test (pval) = 0.987	F-test (pval) = 0.000 % correct = 0.629	
	Total Revenue	*1971–2006*	0.411 (0.208)	-0.156 (0.106)	-0.532 (0.428)	R-sq = 0.38 LM(1) (pval) = 0.190 White Test (pval) = 0.166	F-test (pval) = 0.090 % correct = 0.771	Impulse 1976 Impulse 2000
	Total Expenditure	*1971–2006*	0.627 (0.231)	-0.248 (0.104)	-0.938 (0.209)	R-sq = 0.39 LM(1) (pval) = 0.692 White Test (pval) = 0.835	F-test (pval) = 0.002 % correct = 0.629	
Portugal	**Deficit**	*1997–2006*	0.334 (0.262)	-1.309 (0.381)	-0.459 (0.183)	R-sq = 0.71 LM(1) (pval) = 0.848 White Test (pval) = 0.075	F-test (pval) = 0.027 % correct = 0.886	
	Total Revenue	*1997–2006*	0.023 (0.138)	-0.540 (0.340)	-0.288 (0.166)	R-sq = 0.31 LM(1) (pval) = 0.437 White Test (pval) = 0.822	F-test (pval) = 0.329 % correct = 0.886	
	Total Expenditure	*1997–2006*	0.121 (0.111)	-0.663 (0.296)	-0.411 (0.111)	R-sq = 0.50 LM(1) (pval) = 0.780 White Test (pval) = 0.861	F-test (pval) = 0.134 % correct = 0.800	
Finland	**Deficit**	*1971–2006*	0.950 (0.123)	-0.320 (0.150)	-1.107 (0.188)	R-sq = 0.75 LM(1) (pval) = 0.280 White Test (pval) = 0.903	F-test (pval) = 0.000 % correct = 0.743	
	Total Revenue	*1971–2006*	0.182 (0.264)	-0.114 (0.123)	-0.202 (1.467)	R-sq = 0.20 LM(1) (pval) = 0.306 White Test (pval) = 0.000	F-test (pval) = 0.623 % correct = 0.429	
	Total Expenditure	*1971–2006*	0.868 (0.142)	-0.250 (0.138)	-1.171 (0.224)	R-sq = 0.61 LM(1) (pval) = 0.014 White Test (pval) = 0.095	F-test (pval) = 0.000 % correct = 0.857	

***Notes**:*
See footnotes to Table 4.

Table 6. Error correction models (III): additional variables (as defined in Table 1).

Estimated equation: $\Delta y_t = \alpha_1 \Delta u_t + \alpha_2 \left(y_{t-1} - \alpha_3 u_{t-1} \right) + \sum \omega^j \xi_{t,j} + v_t$, *(y ESA95 annual fiscal variable, u annual fiscal variable in cash accounts both as a ratio to annual nominal GDP, ξ is a set of dummy variables).*

Country	Dependent Variable	*Sample*	Short-term coefficient α_1	Error correction coefficient α_2	Long-term coefficient α_3	Goodness of fit statistics	In-sample tests of predictability	Dummy variables
Belgium	**Direct Taxes**	*1971–2006*	1.094 (0.091)	-0.297 (0.131)	-1.001 (0.098)	R-sq = 0.88 LM(1) (pval) = 0.765 White Test (pval) = 0.496	F-test (pval) = 0.000 % correct = 0.857	Impulse 1991
	Indirect Taxes	*1971–2006*	0.882 (0.173)	-0.686 (0.212)	-1.121 (0.133)	R-sq = 0.46 LM(1) (pval) = 0.670 White Test (pval) = 0.388	F-test (pval) = 0.000 % correct = 0.743	
Germany	**Deficit** Federal government	*1971–2006*	1.891 (0.164)	-0.437 (0.109)	-1.508 (0.125)	R-sq = 0.89 LM(1) (pval) = 0.250 White Test (pval) = 0.140	F-test (pval) = 0.000 % correct = 0.943	Impulse 1990 Impulse 2000
	Total Revenue Federal government	*1971–2006*	0.330 (0.236)	-0.263 (0.075)	-0.171 (0.459)	R-sq = 0.52 LM(1) (pval) = 0.288 White Test (pval) = 0.613	F-test (pval) = 0.003 % correct = 0.600	Impulse 1990 Impulse 2001
	Total Expenditure Federal government	*1971–2006*	1.571 (0.328)	-0.170 (0.061)	-0.581 (0.795)	R-sq = 0.68 LM(1) (pval) = 0.007 White Test (pval) = 0.851	F-test (pval) = 0.000 % correct = 0.714	Impulse 1990 Impulse 2000
	Tax Revenue	*1971–2006*	0.723 (0.296)	-0.194 (0.075)	-0.304 (0.564)	R-sq = 0.51 LM(1) (pval) = 0.167 White Test (pval) = 0.301	F-test (pval) = 0.002 % correct = 0.686	Impulse 1990 Impulse 2001
	Direct Taxes	*1971–2006*	0.858 (0.085)	-0.291 (0.103)	-0.380 (0.122)	R-sq = 0.84 LM(1) (pval) = 0.954 White Test (pval) = 0.022	F-test (pval) = 0.000 % correct = 0.743	Step 1990-94 Impulse 1972
	Indirect Taxes	*1971–2006*	0.878 (0.125)	-0.065 (0.023)	-1.832 (0.067)	R-sq = 0.62 LM(1) (pval) = 0.342 White Test (pval) = 0.700	F-test (pval) = 0.000 % correct = 0.686	
	Consumption Expenditure	*1971–2006*	0.637 (0.135)	-0.297 (0.057)	-0.413 (0.220)	R-sq = 0.70 LM(1) (pval) = 0.509 White Test (pval) = 0.866	F-test (pval) = 0.000 % correct = 0.800	Impulse 1990 Step 1991-94
	Compensation of Employees	*1971–2006*	3.618 (0.602)	-0.181 (0.077)	-2.815 (0.445)	R-sq = 0.74 LM(1) (pval) = 0.005 White Test (pval) = 0.263	F-test (pval) = 0.000 % correct = 0.914	Impulse 1990
Spain	**Current Revenue**	*1985–2006*	0.284 (0.173)	-0.167 (0.085)	0.268 (0.513)	R-sq = 0.57 LM(1) (pval) = 0.438 White Test (pval) = 0.309	F-test (pval) = 0.018 % correct = 0.857	Step 2002-06 Impulse 1995
	Direct Taxes	*1985–2006*	0.714 (0.137)	-0.124 (0.172)	-0.597 (0.664)	R-sq = 0.72 LM(1) (pval) = 0.459 White Test (pval) = 0.003	F-test (pval) = 0.000 % correct = 0.810	Step 2002-06 Impulse 1995
	Indirect Taxes	*1985–2006*	0.371 (0.098)	-0.076 (0.077)	1.449 (1.354)	R-sq = 0.70 LM(1) (pval) = 0.897 White Test (pval) = 0.348	F-test (pval) = 0.001 % correct = 0.571	Step 2002-06 Impulse 1999
	Current Expenditure	*1985–2006*	0.797 (0.182)	-0.141 (0.108)	-0.196 (0.556)	R-sq = 0.60 LM(1) (pval) = 0.195 White Test (pval) = 0.177	F-test (pval) = 0.001 % correct = 0.762	Step 2002-06 Impulse 1992
	Compensation of Employees	*1985–2006*	0.639 (0.343)	-0.140 (0.093)	-0.651 (0.590)	R-sq = 0.30 LM(1) (pval) = 0.174 White Test (pval) = 0.569	F-test (pval) = 0.071 % correct = 0.571	
	Social Payments	*1985–2006*	0.948 (1.062)	-0.065 (0.165)	-6.044 (9.940)	R-sq = 0.29 LM(1) (pval) = 0.000 White Test (pval) = 0.022	F-test (pval) = 0.677 % correct = 0.714	Step 2002-06 Impulse 1995
Italy	**Tax Revenue**	*1986–2006*	0.665 (0.155)	-0.623 (0.137)	-1.529 (0.148)	R-sq = 0.73 LM(1) (pval) = 0.879 White Test (pval) = 0.372	F-test (pval) = 0.000 % correct = 0.950	Impulse 1997
	Current Expenditure	*1986–2006*	0.231 (0.117)	-0.211 (0.094)	-1.451 (0.547)	R-sq = 0.56 LM(1) (pval) = 0.003 White Test (pval) = 0.662	F-test (pval) = 0.022 % correct = 0.700	Step 1994-95

Notes:
See footnotes to Table 4.

Table 7. Tests on the innovations of the annual deficit, revenue and expenditure equation in the mixed-frequencies model. Estimation over the entire sample (1970-2006).

Residual variances

	Belgium	Germany	Spain	France	Italy	Netherlands	Austria	Finland
Deficit	2.49	0.21	0.43	0.64	1.56	1.07	0.55	1.51
Total revenue	1.54	0.53	0.53	0.66	1.54	1.02	1.19	3.93
Total expenditure	0.87	0.35	0.42	0.42	1.03	1.19	0.88	1.98

Q(6)

	Belgium	Germany	Spain	France	Italy	Netherlands	Austria	Finland
Deficit	4.19	2.49	8.94	8.45	8.74	15.28*	10.10	12.14*
Total revenue	27.27*	5.03	9.20	10.24	5.45	7.76	7.90	10.70
Total expenditure	4.72	6.32	9.81	7.09	8.35	9.60	13.03*	3.10

Jarque-Bera

	Belgium	Germany	Spain	France	Italy	Netherlands	Austria	Finland
Deficit	2.99	3.25	0.67	1.20	1.08	0.96	1.11	0.55
Total revenue	1.91	0.55	0.38	1.37	1.29	1.82	1.28	1.37
Total expenditure	0.57	0.34	0.64	0.85	0.27	0.37	1.97	1.09

***Notes**:*
(i) Q(6) is the Ljung-Box pormanteau test of autocorrelation.

(ii) Jarque-Bera is a normality test based on a Chi Squared distribution with two degrees of freedom.

Table 8. Forecast performance statistics I: Belgium, Germany, Spain and France, ratio of the Root Mean Squared Errors (RMSEs) of the different methods to the RMSE of the annual random walk method, for the variables deficit, total revenue and total expenditure as a ratio to nominal GDP.

			Current year		**One year ahead**
			All quarters (q1 to q4)	First half of the year (q1 and q2)	All quarters (q1 to q4)
Belgium	Deficit	MIX	0.54	0.54	0.73
		2ST	0.57	0.59	0.74
		AR1	1.29	1.25	1.39
	Total Revenue	MIX	0.90	0.88	0.92
		2ST	1.07	1.09	1.17
		AR1	1.18	1.19	1.39
	Total Expenditure	MIX	0.83	0.89	0.90
		2ST	0.83	0.89	0.90
		AR1	1.00	1.00	1.05
Germany	Deficit	MIX	0.64	0.63	0.78
		2ST	0.66	0.65	0.78
		AR1	0.91	0.89	0.78
	Total Revenue	MIX	0.80	0.80	0.84
		2ST	0.85	0.85	0.85
		AR1	1.01	1.00	1.03
	Total Expenditure	MIX	1.02	1.16	1.45
		2ST	0.98	1.06	1.29
		AR1	0.99	0.98	0.94
Spain	Deficit	MIX	0.45	0.44	0.61
		2ST	0.47	0.47	0.67
		AR1	1.19	1.15	1.21
	Total Revenue	MIX	0.87	0.86	0.86
		2ST	0.88	0.91	0.83
		AR1	1.14	1.12	1.32
	Total Expenditure	MIX	0.68	0.67	0.65
		2ST	0.68	0.66	0.64
		AR1	0.98	0.95	0.93
France	Deficit	MIX	0.93	0.97	0.93
		2ST	0.91	0.94	0.94
		AR1	0.87	0.87	0.77
	Total Revenue	MIX	0.97	1.00	1.03
		2ST	0.94	0.95	0.97
		AR1	1.13	1.12	1.21
	Total Expenditure	MIX	0.88	0.88	0.93
		2ST	0.88	0.88	0.93
		AR1	1.08	1.07	1.11

Table 9. Forecast performance statistics II: Italy, Netherlands, Austria and Finland, ratio of the Root Mean Squared Errors (RMSEs) of the different methods to the RMSE of the annual random walk method, for the variables deficit, total revenue and total expenditure as a ratio to nominal GDP.

			Current year		One year ahead
			All quarters (q1 to q4)	First half of the year (q1 and q2)	All quarters (q1 to q4)
Italy	Deficit	MIX	0.73	0.82	0.95
		2ST	0.70	0.78	0.94
		AR1	1.14	1.12	1.18
	Total Revenue	MIX	0.81	0.94	1.22
		2ST	0.85	0.95	1.07
		AR1	1.00	1.00	0.95
	Total Expenditure	MIX	0.79	0.84	0.88
		2ST	0.81	0.85	0.93
		AR1	0.93	0.94	0.90
Netherlands	Deficit	MIX	0.71	0.75	0.79
		2ST	0.73	0.78	0.80
		AR1	1.01	1.00	0.99
	Total Revenue	MIX	0.78	0.72	0.77
		2ST	0.87	0.85	0.79
		AR1	1.03	1.01	1.09
	Total Expenditure	MIX	0.61	0.59	0.62
		2ST	0.65	0.66	0.61
		AR1	1.10	1.07	1.13
Austria	Deficit	MIX	0.64	0.63	0.83
		2ST	0.66	0.66	0.87
		AR1	0.91	0.90	0.76
	Total Revenue	MIX	0.88	0.85	0.98
		2ST	0.74	0.71	0.90
		AR1	0.87	0.85	0.80
	Total Expenditure	MIX	0.93	0.93	1.00
		2ST	0.81	0.78	0.81
		AR1	0.91	0.90	0.84
Finland	Deficit	MIX	0.68	0.66	0.89
		2ST	0.65	0.67	0.91
		AR1	0.91	0.92	0.87
	Total Revenue	MIX	0.95	0.98	1.29
		2ST	0.96	0.95	1.45
		AR1	1.06	1.05	0.99
	Total Expenditure	MIX	0.92	0.90	0.87
		2ST	0.90	0.92	0.83
		AR1	0.93	0.96	0.91

Table 10. Forecast performance statistics III: current year forecasts, DM test.

		Deficit			Total revenue			Total expenditure		
		MIX	2ST	AR1	MIX	2ST	AR1	MIX	2ST	AR1
Belgium	2ST	-1.64*	--	--	-2.06**	--	--	-0.60	--	--
	AR1	-3.04***	-3.07***	--	-2.07**	-1.45*	--	-3.02***	-3.02***	--
	ARW	-2.23**	-2.23**	3.96***	-1.52*	1.23	2.03**	-3.10***	-3.10***	0.05
Germany	2ST	-1.17	--	--	-2.05**	--	--	0.48	--	--
	AR1	-2.97***	-2.78***	--	-2.13**	-1.93**	--	0.14	-0.06	--
	ARW	-2.83***	-2.71***	-1.25	-1.46*	-1.21	0.14	0.09	-0.16	-0.23
Spain	2ST	-0.78	--	--	-0.15	--	--	0.80	--	--
	AR1	-4.58***	-4.62***	--	-1.49*	-2.01**	--	-3.09***	-3.23***	--
	ARW	-3.56***	-3.68***	2.42***	-1.28	-2.42***	1.55*	-2.58***	-2.66***	-0.26
France	2ST	0.77	--	--	0.28	--	--	-0.22	--	--
	AR1	0.45	0.35	--	-0.97	-2.86***	--	-2.00**	-2.00**	--
	ARW	-0.67	-0.99	-3.11***	-0.24	-2.17**	2.48***	-2.43***	-2.43***	0.99
Italy	2ST	1.45*	--	--	-0.82	--	--	-0.89	--	--
	AR1	-1.85**	-1.96**	--	-2.01**	-1.97**	--	-2.80***	-2.28**	--
	ARW	-1.64*	-1.83**	1.96**	-2.34**	-2.34**	0.22	-2.30**	-2.12**	-1.68**
Netherlands	2ST	-1.93**	--	--	-1.88**	--	--	-0.66	--	--
	AR1	-3.94***	-3.84***	--	-3.02***	-2.51***	--	-3.37***	-3.97***	--
	ARW	-4.49***	-4.50***	0.29	-2.31**	-1.75**	0.70	-2.77***	-3.33***	2.56***
Austria	2ST	-2.18**	--	--	2.18**	--	--	1.99**	--	--
	AR1	-2.01**	-1.91**	--	0.05	-0.93	--	0.33	-2.98***	--
	ARW	-2.35**	-2.31**	-1.52*	-1.23	-2.81***	-1.50*	-1.75**	-2.81***	-2.03**
Finland	2ST	0.83	--	--	-0.29	--	--	0.57	--	--
	AR1	-2.33**	-2.43***	--	-1.01	-0.91	--	-0.36	-1.04	--
	ARW	-3.03***	-3.12***	-4.29***	-0.87	-0.62	1.08	-2.81***	-3.00***	-2.86***

Notes:
Diebold-Mariano test for the null hypothesis of equal forecast accuracy of two forecast methods: mixed-frequency model (MIX), bridge equation method (2ST), autoregressive model of order 1 (AR1), annual random walk (ARW). A squared loss function is used. The number in each cell represents the loss differential of the method in its vertical column as compared to the method in the horizontal line (a negative value means that the loss associated to the method in the horizontal line is higher than that of the method in the vertical column).

The Diebold-Mariano statistic follows a N(0,1) distribution. A single (double) [triple] asterisk denotes rejection of the null hypothesis at the 10% (5%) [1%] significance level.

Table 11. Forecast performance statistics IV: current year forecasts (using information for the first half of the year), DM test.

		Deficit			Total revenue			Total expenditure		
		MIX	2ST	AR1	MIX	2ST	AR1	MIX	2ST	AR1
Belgium	2ST	-1.66*	--	--	-1.77**	--	--	-0.70	--	--
	AR1	-2.30**	-2.32**	--	-1.60*	-1.05	--	-1.57*	-1.57*	--
	ARW	-1.73**	-1.73**	3.04***	-1.29	1.69**	1.74**	-2.09**	-2.09**	0.04
Germany	2ST	-0.97	--	--	-1.39*	--	--	0.97	--	--
	AR1	-2.22**	-2.02**	--	-1.70**	-1.60*	--	0.70	0.45	--
	ARW	-2.36***	-2.22**	-1.39*	-1.10	-0.95	0.05	0.67	0.39	-0.37
Spain	2ST	-1.04	--	--	-0.67	--	--	0.82	--	--
	AR1	-3.59***	-3.52***	--	-1.26	-1.51*	--	-2.85***	-3.09***	--
	ARW	-2.98***	-3.03***	1.49*	-1.16	-1.66*	1.30*	-2.30**	-2.42***	-0.56
France	2ST	0.93	--	--	0.27	--	--	-0.30	--	--
	AR1	0.65	0.55	--	-0.53	-2.19**	--	-1.78**	-1.78**	--
	ARW	-0.21	-0.53	-2.86***	-0.01	-1.60*	1.86**	-2.67***	-2.67***	0.83
Italy	2ST	1.49*	--	--	-0.27	--	--	-0.37	--	--
	AR1	-1.44*	-1.55*	--	-0.90	-0.80	--	-1.86**	-1.73**	--
	ARW	-1.32*	-1.55*	1.40*	-1.31*	-1.08	-0.11	-1.60*	-1.58*	-1.32*
Netherlands	2ST	-2.40***	--	--	-1.90**	--	--	-0.92	--	--
	AR1	-2.70***	-2.45***	--	-2.76***	-1.98**	--	-2.73***	-3.22***	--
	ARW	-3.85***	-3.75***	0.06	-2.10**	-1.47*	0.14	-2.31**	-2.74***	1.75**
Austria	2ST	-2.26**	--	--	1.66*	--	--	1.69**	--	--
	AR1	-1.61*	-1.50*	--	0.00	-0.80	--	0.41	-2.60***	--
	ARW	-1.81**	-1.76**	-1.21	-1.38*	-2.57***	-1.46*	-1.22	-2.40***	-1.67**
Finland	2ST	-0.80	--	--	0.69	--	--	-0.41	--	--
	AR1	-2.51***	-2.53***	--	-0.50	-0.84	--	-1.97**	-1.41*	--
	ARW	-2.87***	-2.89***	-3.17***	-0.26	-0.83	0.72	-3.08***	-2.04**	-1.73**

Note:
Diebold-Mariano test for the null hypothesis of equal forecast accuracy of two forecast methods: mixed-frequency model (MIX), bridge equation method (2ST), autoregressive model of order 1 (AR1), annual random walk (ARW). A squared loss function is used. The number in each cell represents the loss differential of the method in its vertical column as compared to the method in the horizontal line (a negative value means that the loss associated to the method in the horizontal line is higher than that of the method in the vertical column).

The Diebold-Mariano statistic follows a N(0,1) distribution. A single (double) [triple] asterisk denotes rejection of the null hypothesis at the 10% (5%) [1%] significance level.

Table 12. Forecast performance statistics V: one year ahead forecasts, DM test.

		Deficit			Total revenue			Total expenditure		
		MIX	2ST	AR1	MIX	2ST	AR1	MIX	2ST	AR1
Belgium	2ST	-0.97	--	--	-1.56*	--	--	-0.50	--	--
	AR1	-3.18***	-3.18***	--	-2.30**	-2.08**	--	-2.13**	-2.13**	--
	ARW	-1.61*	-1.60*	4.78***	-0.76	1.78**	3.27***	-1.77**	-1.77**	1.38*
Germany	2ST	-0.06	--	--	-0.22	--	--	1.62*	--	--
	AR1	0.02	0.03	--	-2.01**	-2.54***	--	2.02**	1.95**	--
	ARW	-2.37***	-2.45***	-2.78***	-1.43*	-1.65*	0.31	1.88**	1.79**	-0.95
Spain	2ST	-3.35***	--	--	0.40	--	--	0.95	--	--
	AR1	-5.24***	-4.76***	--	-2.07**	-2.76***	--	-2.97***	-3.04***	--
	ARW	-3.53***	-3.25***	2.31**	-1.01	-1.94**	3.11***	-2.65***	-2.69***	-0.72
France	2ST	-1.64*	--	--	0.41	--	--	-0.25	--	--
	AR1	1.39*	1.54*	--	-0.80	-2.51***	--	-1.17	-1.17	--
	ARW	-0.97	-0.79	-4.79***	0.20	-0.77	2.93***	-1.40*	-1.40*	1.00
Italy	2ST	1.59*	--	--	2.35**	--	--	-1.17	--	--
	AR1	-1.64*	-1.76**	--	3.10***	1.66*	--	-1.15	0.61	--
	ARW	-0.46	-0.65	2.55***	3.10***	1.39*	-1.90**	-1.62*	-0.90	-1.55*
Netherlands	2ST	-1.96**	--	--	-0.32	--	--	0.21	--	--
	AR1	-2.09**	-2.02**	--	-2.52***	-3.03***	--	-3.40***	-3.87***	--
	ARW	-3.50***	-3.44***	-0.26	-2.10**	-2.67***	1.10	-2.41***	-2.84***	3.16***
Austria	2ST	-2.94***	--	--	1.16	--	--	2.72***	--	--
	AR1	0.87	1.26	--	2.38***	1.64*	--	1.96**	-1.28	--
	ARW	-1.94**	-1.51*	-2.57***	-0.17	-1.11	-2.93***	-0.01	-3.27***	-2.75***
Finland	2ST	-1.76**	--	--	-1.04	--	--	0.80	--	--
	AR1	0.13	0.21	--	3.29***	2.09**	--	-0.82	-1.38*	--
	ARW	-0.59	-0.50	-4.28***	3.91***	2.13**	-0.30	-2.79***	-2.81***	-3.11***

Note:
Diebold-Mariano test for the null hypothesis of equal forecast accuracy of two forecast methods: mixed-frequency model (MIX), bridge equation method (2ST), autoregressive model of order 1 (AR1), annual random walk (ARW). A squared loss function is used. The number in each cell represents the loss differential of the method in its vertical column as compared to the method in the horizontal line (a negative value means that the loss associated to the method in the horizontal line is higher than that of the method in the vertical column).

The Diebold-Mariano statistic follows a N(0,1) distribution. A single (double) [triple] asterisk denotes rejection of the null hypothesis at the 10% (5%) [1%] significance level.

Table 13. Forecasting the fiscal deficit as a % of GDP: direct forecast or forecast by disaggregates?

		RMSE				Diebold-Mariano test	
		Deficit [1]: direct forecast	**Deficit [2]: revenue - expenditure**	**[1] / [2]**			**Deficit = revenue-expenditure**
		ratio to annual random walk	ratio to annual random walk	ratio			
Belgium	MIX	0.54	0.74	0.73	**Deficit**	MIX	1.34*
	2ST	0.57	0.94	0.61		2ST	1.76**
	AR1	1.29	1.24	1.04		AR1	-2.01**
Germany	MIX	0.64	0.77	0.83	**Deficit**	MIX	1.12
	2ST	0.66	0.75	0.88		2ST	1.15
	AR1	0.91	0.95	0.96		AR1	0.78
Spain	MIX	0.45	0.87	0.52	**Deficit**	MIX	2.63***
	2ST	0.47	0.87	0.54		2ST	2.81***
	AR1	1.19	1.26	0.94		AR1	1.23
France	MIX	0.93	0.88	1.06	**Deficit**	MIX	-0.28
	2ST	0.91	0.87	1.05		2ST	-0.52
	AR1	0.87	1.00	0.87		AR1	2.68***
Italy	MIX	0.73	0.72	1.01	**Deficit**	MIX	-0.09
	2ST	0.70	0.80	0.88		2ST	1.18
	AR1	1.14	0.92	1.24		AR1	-1.96**
Netherlands	MIX	0.71	0.74	0.96	**Deficit**	MIX	0.20
	2ST	0.73	0.79	0.92		2ST	0.45
	AR1	1.01	1.10	0.92		AR1	1.33*
Austria	MIX	0.64	0.72	0.89	**Deficit**	MIX	0.95
	2ST	0.66	0.73	0.90		2ST	0.82
	AR1	0.91	0.94	0.97		AR1	1.07
Finland	MIX	0.68	0.89	0.76	**Deficit**	MIX	2.34**
	2ST	0.65	0.83	0.78		2ST	2.18**
	AR1	0.91	0.99	0.92		AR1	3.68***

Note:
RMSEs and Diebold-Mariano test for the null hypothesis of equal forecast accuracy of two forecast methods: mixed-frequency model (MIX), bridge equation method (2ST), autoregressive model of order 1 (AR1), annual random walk (ARW).

For the Diebold-Mariano test a squared loss function is used; the number in each cell represents the loss differential of the deficit forecast using the direct forecast of deficit and the disaggregated method (deficit=revenue=expenditure), both with the method in the horizontal line. A positive value means that, given the method (MIX, 2ST or AR1), the "direct forecast of deficit" loss is lower.

The Diebold-Mariano statistic follows a N(0,1) distribution. A single (double) [triple] asterisk denotes rejection of the null hypothesis at the 10% (5%) [1%] significance level.

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