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Measuring the Uncertainty in Predicting Public Revenue

Gilles Mourre, Caterina Astarita
and Anamaria Maftai

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Measuring the Uncertainty in Predicting Public Revenue

Gilles Mourre, Caterina Astarita and Anamaria Maftai

Abstract

This paper provides an assessment of the uncertainty surrounding revenue predictions, through an ex post analysis of European Commission's forecasts over the last 15 years. It estimates the forecast errors affecting revenue for all 28 Member States, using the different vintages of the autumn and spring Commission forecasts. It analyses both the direction and magnitude of errors, using standard summary statistics. The paper looks into the various components of forecast errors to better understand their drivers (forecasting error related to real GDP, inflation or revenue-to-GDP ratio) and which types of revenues (direct tax, indirect tax or social security contributions) are particularly affected. The paper also examines the pattern of revenue errors over time and in particular how revenue forecasts perform before, during and after the crisis. To further deepen the analysis, a set of tests are carried out on the quality of the prediction (serial correlation, unbiasedness, weak and informational efficiency). The estimator-based tests confirm the sound track record of the European Commission's forecasts. This is also shown by a comparison with the OECD's revenue forecasts. Lastly, the paper reviews various possible determinants of forecast errors and examines their significance by means of a pooled time series technique. The econometric study allows for the identification of factors which increase or reduce the risk of over-forecasting revenue.

JEL Classification: C1, E60, E66.

Keywords: European Commission's forecasts, accuracy, public revenue, statistical properties, forecast errors, forecasting performance, bias, crisis.

Contact: Caterina Astarita, European Commission, Directorate-General for Economic and Financial Affairs (Caterina.ASTARITA@ec.europa.eu). Anamaria Maftai was working at the Directorate-General for Economic and Financial Affairs at the time of the production of the analysis underlying this paper.

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INTRODUCTION

The conduct of fiscal policy faces the usual difficulty of accurately predicting the various components of the budget, not least the amount of public revenue. This is traditionally different between ex ante assessment and ex post outturn. Ex post revenue shortfalls (windfalls) often arise from an overestimation (underestimation) of the economic activity. Moreover, the recent economic crisis has highlighted the importance of asset price movements, in particular in the housing sector. While some countries recorded sizeable revenues windfalls before the crisis, these latter became very large tax shortfalls (i.e. less VAT on new construction and transaction taxes) when the bubbles in the housing market busted in some countries, in particular Spain. Negative confidence effects in 2009, causing precautionary savings, may also have reduced consumption taxes. These tax shortfalls/windfalls – not fully explained by the variation of the traditional business cycle - will distort the measure of the structural budget balance (cyclically-adjusted budget balance corrected for one-off), which variation is a key measure of the fiscal stance, that is, the discretionary policy. Barrios and Rizza (2010) analyse the size and the determinants of unexpected changes in EU countries' tax revenues and their impact on the ability of EU governments to use fiscal policy as a macroeconomic stabilisation device. They make use of information available in the Stability and Convergence Programmes (SCP) setting countries' medium-term fiscal plans and focus on the period preceding the 2008/2009 global financial crisis. This approach, comparing the plan and ex post observation, has become popular (Alesina, Giavazzi and Favero, 2014). Tax revenue “surprises” are found to have fluctuated widely, alternating periods of sizeable windfalls and periods of substantial shortfalls. While tax revenue windfalls may be good for the public finance during good times they may also weaken the ability of the countries concerned to run countercyclical fiscal policies when cyclical conditions become less favourable.

This is the reason why the revision of the Stability and Growth Pact in 2011, part of the so-called Six-Pack legislation, added an expenditure benchmark. The latter complements the structural balance, the interpretation of which could be affected by revenue shortfalls/windfalls out of the government control. The expenditure benchmark considered the developments of public expenditures minus discretionary revenue measures and compared it with the average growth of the potential output. However, this contributes to only partly address the issue as discretionary revenue measures cannot be predicted either with high certainty. Moreover, forecasting non-discretionary measures is useful to assess the trend in headline budget balance and the development in public debt.

The paper tries to analyse the predictability of revenue developments in the EU countries, by means of an ex post assessment of European Commission forecast, which examines the forecast errors, calculated as the difference between the forecast and the realization. This approach complements that of comparing the budgetary plans of Member States and the ex post observation. Focusing on the Commission forecasts, among many available forecasts, offers various advantages, as it is considered as a 'main stream' forecast with a good track record. Indeed, several studies, performed on European Commission forecasts over different time span, (Keereman, 1999; Melander et al., 2007; González Cabanillas et al., 2012; Fioramanti et al., 2016) concluded, *inter alia*, that these forecasts have a reasonable track record as regarding real GDP growth, inflation, general government balance, unemployment rate, current account and total investment. The most recent analysis by Fioramanti et al. (2016) confirms the absence of bias in current-year GDP forecasts (spring forecast) across EU Member States, although year-ahead forecasts for GDP growth (autumn forecast) tend to be slightly over optimistic across the whole sample. The forecasts of the European Commission are key instruments for several economic surveillance procedures. Moreover, these forecasts are available for all 28 countries and the different vintages of these forecasts can be used for a reasonable time span of over a decade (2001-2013). Up to 2012, two forecasts exercises per year were scheduled: in spring and in autumn. A third forecast exercise for winter has been added in 2013. At the same time, we run a robustness analysis to see whether a mainstream forecast, namely the OECD Economic Outlook covering most of the EU countries, delivers differently in terms of accuracy of revenue forecast.

In the strand of literature related to forecast performance, the contribution of this paper is twofold. First, it focuses on the forecast errors of public revenue and its components: total tax revenue along with the specific

tax categories of direct, indirect and social security contributions. Second, it supplements an in-depth analysis on the time series and cross country dimension of revenue forecasting errors, by means of a battery of complementary summary statistics and standard forecasting tests, with an econometric analysis aiming at shedding light on the possible drivers of revenue forecast inaccuracy. The dataset available, for the period 2001-2013 covering 28 Member States, allows for panel data analysis. The model, estimated by fixed effect estimator with time dummies include several control variables reflecting the economic and political environment.

The paper is organised as follows. Section 1 provides a description of the data used and presents the methodology for the computation and measures of forecast errors, following a short review of the relevant literature. Section 2 analyses errors both from a cross-time and cross-country perspective, using various summary error estimators and include a comparison between the European Commission and OECD data. Its aim is to highlight possible differences between the pre-crisis, crisis and consolidation period along with identifying possible country clusters. Forecasting accuracy tests are performed in Section 3 to check for serial correlation, unbiasedness, weak and informational efficiency. Section 4 explores the main drivers of the forecast errors using panel data econometric techniques. The conclusions are drawn in the last section.

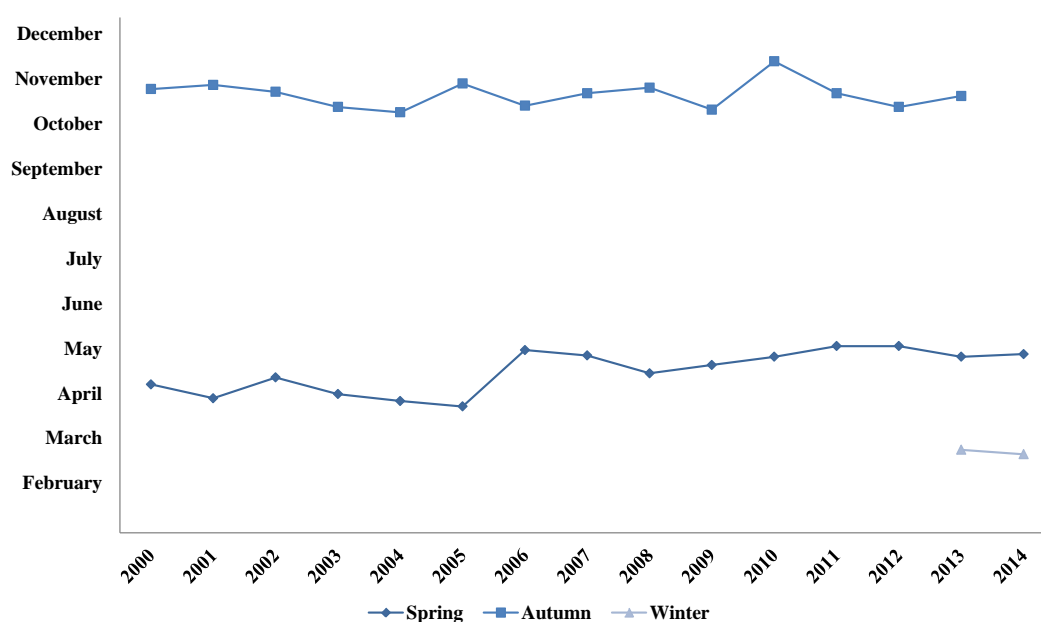
1. CONSTRUCTING THE SHORT-TERM ERRORS IN REVENUE FORECAST

1.1. DATA

The dataset used in this paper is derived from different vintages of the macroeconomic database AMECO¹, which encapsulate the European Commission spring and autumn forecasts starting in 2000. The forecast and outturn data are extracted from 29 AMECO data vintages: 15 spring forecasts (2000-2014) and 14 autumn forecasts (2000-2013), covering all 28 Member States². The forecast calendar varies from one year to another (Figure 1) and it consists of two exercises per year, one in spring and one in autumn. An additional exercise was organised in winter 2013 and 2014, bringing the number to three. As illustrated in Figure 1, the timing for the autumn exercise has been more stable (end of October – early November) compared to the forecast conducted in spring (early April – early May).

The errors are calculated systematically for six AMECO variables: i) Total nominal revenue (at current prices); ii) Taxes linked to imports and production (indirect taxes, nominal); iii) Current taxes on income and wealth (direct taxes, nominal); iv) Social contributions received (nominal); v) Real GDP; vi) GDP deflator³. Moreover, the errors are calculated for the revenue-to-GDP ratio.

Figure 1: Finalisation date of the forecast



Source: Own elaboration based on Ameco finalisation dates

¹ AMECO is the annual macro-economic database of the European Commission's Directorate General for Economic and Financial Affairs (DG ECFIN).

² ESA95 methodology is applied throughout the entire time series.

³ The AMECO codes of the variables are: URTG (total nominal revenue), UTVG (taxes linked to imports and production), UTYG (current taxes on income and wealth), UTSG (social contributions received), OVGDP gross domestic product at constant market prices and PVGDP (price deflator gross domestic product at market prices). The revenue-to-GDP ratio is calculated as the ratio between URTG and OVGDP.

1.2. DEFINING THE ERROR VARIABLES

The forecast error for year (t) is calculated as the difference between the forecast and the realisation (outturn) for that specific year:

$$e_t = F_t - R_t$$

As for the forecast and the realisation values, they are estimated as annual rates of change, as shown in Table 1 (the forecasting exercise from which the data are retrieved is placed in brackets):

Table 1: Forecast and realisation estimations (annual rates of change)

Current year	
$F_t = \frac{\text{forecast}_{t(t)} - \text{first available estimate}_{t-1(t)}}{\text{first available estimate}_{t-1(t)}} \times 100$	$R_t = \frac{\text{first available estimate}_{t(t+1)} - \text{revision}_{t-1(t+1)}}{\text{revision}_{t-1(t+1)}} \times 100$
Year-ahead	
$F_t = \frac{\text{forecast}_{t(t-1)} - \text{forecast}_{t-1(t-1)}}{\text{forecast}_{t-1(t-1)}} \times 100$	$R_t = \frac{\text{first settled estimate}_{t(t+1)} - \text{revision}_{t-1(t+1)}}{\text{revision}_{t-1(t+1)}} \times 100$

The forecasts

The spring forecast includes predictions for the current (t) and the following year ($t+1$), while the autumn forecast also covers year ($t+2$). Being concerned both with the spring projections carried out at the beginning of the year for the same year (or the *current year forecast*) and with those of the autumn outlook for the following year (the *year-ahead forecast*), the forecast data for year t will be selected from:

- the spring forecast carried out at the beginning of the same year, and
- the autumn forecast projected at the end of year $t-1$.

The annual rates of change are computed by comparing these forecast levels to the data from the previous year, which represent:

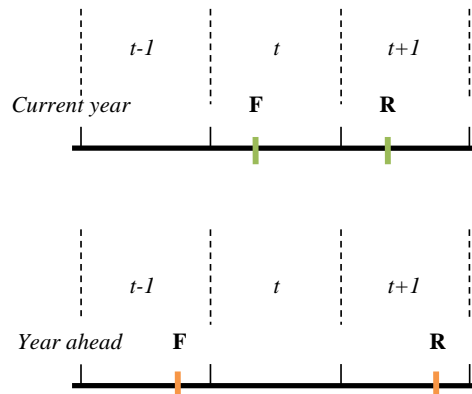
- the realisation of year $t-1$ – for the spring exercise and
- the forecast of year $t-1$ – for the autumn exercise.

As a general caveat and regardless of the exercise, the later in the year the forecasts are made, the more information is available and the more precise the projections are likely to be.

The realisations

The realisations are computed in the same manner for both the spring and autumn forecasts, i.e. the outturn for year t is extracted from the exercise organized the subsequent year ($t+1$). The outcome data are referred to as 'first available estimates' (for the current year forecast) and 'first settled estimates' (for the year-ahead forecast). As argued by Keereman (1999), these estimates are preferred to any later revisions due to: i) accuracy reasons, driven by the necessity of a swift confirmation if a policy reaction is required (for the spring 'first available estimates'); ii) precision reasons (for the autumn 'first settled estimates'). Furthermore, these estimates are not altered by new information or methodological changes that occur over the years. The final data may be subject to several revisions and the forecaster predicts only the immediate evolution of the variable and cannot be accounted for envisaging all possible future changes. Figure 2 represents schematically the time relation between the forecasts (F) and the outturns (R), both in the case of current year and year-ahead projections.

Figure 2: The time perspective of forecast and outturn data



Source: Adapted from Keereeman (1999)

1.3. USING A SET OF SUMMARY STATISTICS

The paper makes use of a set of complementary revenue statistics so as to describe the main features of the errors in revenue projections. Each revenue statistic presents some peculiar features and provides a specific type of information. Mean error, mean absolute error and root mean squared error are some of the most used accuracy (error) measures in the forecasting field. The selected accuracy measures are defined as follows:

- The mean error (ME) is the average difference between the forecast and the outturn. A positive (negative) sign indicates the tendency to over (under) estimation. It can be considered as a rough indicator of quality as positive and negative errors can offset each other, thereby limiting the size of the error. The ME is however a pointer to a possible bias in the forecast. Formally,

$$ME = \frac{1}{T} \sum_{t=1}^T e_{t,t} \text{ for the current year}$$

$$ME = \frac{1}{T} \sum_{t=1}^T e_{t+1,t} \text{ for the year-ahead}$$

- The mean absolute error (MAE) is the average of the errors expressed in absolute terms, i.e. the absolute value of the difference between the forecast and the outturn. Negative errors are treated as positive ones meaning that errors can no longer cancel each other out. The MAE is thus a more accurate measure of the average forecast error than the ME. On the other hand, the relative size of the forecast error is not taken into account. MAE can vary between 0 and $+\infty$. Formally,

$$MAE = \frac{1}{T} \sum_{t=1}^T |e_{t,t}| \text{ for the current year}$$

$$MAE = \frac{1}{T} \sum_{t=1}^T |e_{t+1,t}| \text{ for the year-ahead}$$

- The root mean squared error (RMSE), similar to the standard deviation, is a measure of the relative size of the forecast error. The squaring attributes more weight to large error than to smaller ones. The value of RMSE can vary between 0 and $+\infty$ and, being influenced by extreme values, makes the comparability between series not always straightforward. Formally,

$$RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^T e_{t,t}^2} \text{ for the current year}$$

$$RMSE = \sqrt{\frac{1}{T} \sum_{t=1}^T e_{t+1,t}^2} \text{ for the year-ahead}$$

Summary statistics of the forecast errors for nominal revenue, direct taxes, indirect taxes and social contributions are presented below (Tables 2 and 3), while the complete set of results is included in Annex A. The MAE will be used as the main indicator, but systematically completed by ME, to check if errors of different sign tend to offset each other over time. RMSE will be referred to, when relevant, to signal the existence of potentially large errors, which are then overweighed⁴.

⁴ The RMSE will always be larger or equal to the MAE; the greater the difference between the two indicators, the greater the variance in the individual errors in the sample. If the RMSE=MAE, then all the errors are of the same magnitude.

2. CHARACTERISTICS OF THE ERRORS

2.1. FORECAST ERROR IN NOMINAL REVENUE

2.1.1. EU-wide revenue errors, based on spring forecast

Regarding the current year outlook, the absolute forecast error as measured by the MAE is smaller for the EU and euro area aggregates than for the individual countries (with the exception of France that reaches the minimum level of 0.81 pp.). Judging from Table 2, the overall impression is that accuracy represents a salient issue predominantly in the new Member States. If the prediction error broadly remains around 2.00 pp. in the old Member States, it almost doubles for the more recently acceded countries.

At EU level, the absolute error measured by ME is significantly smaller than the MAE indicator (-0.18 pp.), broadly reflecting offsetting errors of different sign across time. The ME estimator proves to be just as revealing as the mean absolute error. The ME error for the euro area aggregate is close to zero (-0.03 pp.), suggesting that the negative errors are counterbalancing the positive ones. However, the negative sign of both aggregates clearly indicates the tendency of most Member States (three quarters of the EU countries) to underestimate the government receipts over the observed period.

Table 2: Forecast errors for nominal revenue

Member State	Sample		ME		MAE		RMSE	
	current year	year-ahead	current year	year-ahead	current year	year-ahead	current year	year-ahead
Austria	Jan-13	01-Dec	-0.71	-0.67	1.03	1.84	1.29	2.32
Belgium	Jan-13	01-Dec	-0.89	-0.36	1.31	1.63	1.62	2.24
Denmark	Jan-13	01-Dec	-1.27	-0.16	1.81	1.88	2.53	2.44
Finland	Jan-13	01-Dec	-0.01	0.05	1.73	2.84	2.08	3.63
France	Jan-13	01-Dec	0.1	0.29	0.81	1.23	1	2.09
Germany	Jan-13	01-Dec	-0.43	0.21	1.6	2.33	1.8	2.65
Greece	Jan-13	01-Dec	0.51	1.13	2.67	3.73	3.56	5.3
Ireland	Jan-13	01-Dec	0.11	1.51	3.59	4.7	4.86	6.74
Italy	Jan-13	01-Dec	0.11	0.41	1.43	1.73	1.84	2.21
Luxembourg	Jan-13	01-Dec	-1.7	-1	1.78	2.03	2.26	2.67
Netherlands	Jan-13	01-Dec	-0.06	0.53	1.42	2.63	1.83	3.39
Portugal	Jan-13	01-Dec	-0.62	0.01	2.62	4.15	3.22	4.94
Spain	Jan-13	01-Dec	0.75	1.05	2.96	3.78	4.08	5.33
Sweden	Jan-13	01-Dec	-1.22	-0.22	1.61	1.52	1.88	1.93
United Kingdom	Jan-13	01-Dec	-0.55	0.12	1.23	1.97	1.39	3.13
Bulgaria	Jun-13	07-Dec	-0.51	1.51	5.52	6.71	6.79	10.26
Croatia	Jun-13	07-Dec	-1.93	3.21	8.51	4.79	14.38	6.5
Cyprus	May-13	04-Dec	-1.7	0.67	5.19	5.64	6.34	7.48
Czech Republic	Feb-13	03-Dec	0.62	1.88	2.14	2.63	2.72	3.75
Estonia	Apr-13	02-Dec	-1.86	-2.19	3.93	5.93	4.95	7.15
Hungary	Apr-13	04-Dec	-1.9	-1.97	2.7	5.45	3.61	8.92
Latvia	Mar-13	03-Dec	-4.55	-5.54	6.81	12.14	8.53	13.1
Lithuania	Mar-13	03-Dec	-0.67	-0.5	4.45	6.56	5.08	9.69
Malta	May-13	04-Dec	-0.69	-1.32	1.87	2.86	2.29	3.85
Poland	Jan-13	02-Dec	0.98	0.72	2.54	3.06	3.03	4.04
Romania	Jun-13	07-Dec	-0.65	1.41	5.6	6.39	6.8	9.28
Slovakia	Mar-13	03-Dec	-1.59	3.92	4.97	5.16	6.71	8.49
Slovenia	May-13	04-Dec	-0.48	0.85	1.05	2.66	1.35	3.69
Euro Area	Jan-13	01-Dec	-0.03	0.39	0.92	1.54	1.17	2.3
European Union	Jan-13	01-Dec	-0.18	0.55	0.88	2.23	1.14	3.21

2.1.2. Comparing errors between spring and autumn revenue forecasts over time

For the year-ahead outlook, the forecast error follows the same pattern over time as the current year forecast, but the magnitude of autumn forecast error is much larger. For almost every year, the forecast errors in the EU and the euro area have the same sign in both spring and autumn and develop in the same way over time. However, the MAE for the autumn prediction at EU level is almost triple relative to the spring one: for almost every year, the error is larger in the autumn forecast. The largest gap is registered in the recession year 2009 (almost 8.5 pp), difference that can be explained by the unanticipated speed at which the crisis spread and deepened.

Figure 3: Development of the EU nominal revenue error

Three specific periods can be distinguished, as suggested by Figure 3 and also Tables A1-A2 in Annex A:

- pre-crisis years (2001-2007) characterized by slightly negative errors in both EU and the euro area. The MAE estimators generally remain around the level of 1 pp. for spring and autumn forecasts;
- the crisis outbreak (2008-2010) exhibiting the poorest forecasting performance, in particular for the autumn forecasts (5.2 pp. at EU level in absolute terms, compared to 1.3 pp for the spring exercise). Revenue growth outturns in 2008 and 2009 were substantially weaker than had been projected. By contrast, the revenue growth in 2010 was underestimated by the forecast. The clear deterioration of the predictions is due to strong economic volatility, proving difficult for the forecaster to anticipate major turning points.
- the consolidation period (2011-2013) was characterised by a noticeable improvement in the forecast accuracy, outperforming even the levels from the pre-crisis years.

2.1.3. A recent improvement of forecast accuracy across most Member States

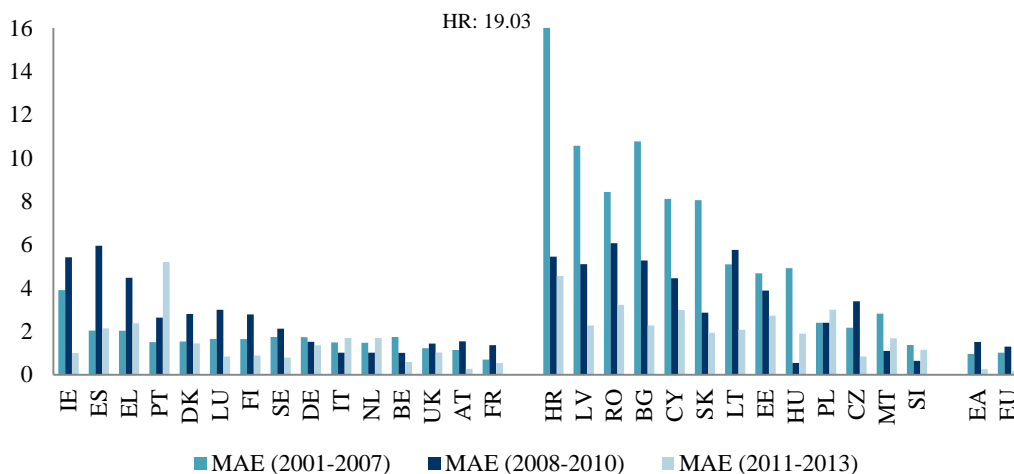
The aggregate forecasts mask diverging developments at country level. In order to better understand the forecast performance across Member States, Figure 4 presents the MAE by country. The Members States were sorted in a descending order according to the total MAE (2001-2013). We can observe that, for the old Member States (EU-15), the revenue forecast was generally less accurate during the economic crisis, for both the current year and the year-ahead outlook. The MAE for the spring forecast is almost twice as high during the financial crisis versus the previous period, and almost three times as large for the autumn outlook. The dispersion of the ME and MAE across EU countries, measured by the cross-country standard deviation, is very telling in this respect: 1.1 p.p. of revenue growth for ME and 1.9 p.p. of revenue growth for MAE in the spring forecast. The dispersion is significantly higher for the autumn forecast: 1.7 p.p. of revenue growth for ME and 2.3 p.p. of revenue growth for MAE.

The dispersion of average absolute errors across EU countries was the highest before the crisis and the lowest after it. In the pre-crisis years, the dispersion of average forecast error across countries (measured by the

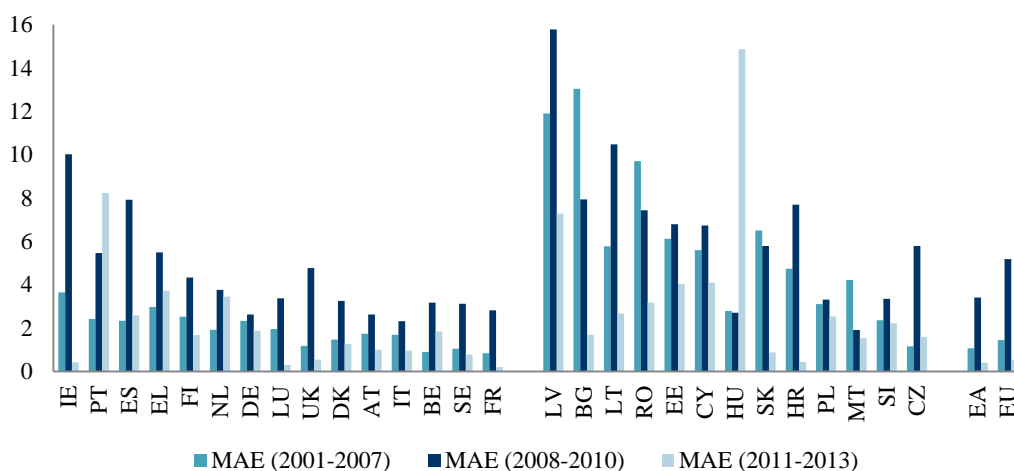
standard deviation of MAE in EU countries in spring forecast) is, however, the strongest of the whole time sample (4.1 p.p. of nominal revenue growth), due to the very high forecast error for new Member States before and in the wake of the accession. In the crisis outbreak, the dispersion of the average forecast error across countries remains high: 1.8p.p. of nominal revenue growth. During the post-crisis years, the dispersion of the average forecast error across countries is the lowest of the sample (1.1 p.p. of nominal revenue growth), although still not negligible.

Figure 4: Development of the EU nominal revenue error

(a) current-year forecast



(b) year-ahead forecast



The picture is somewhat different in the recently acceded countries, which seem to exhibit a less satisfactory forecasting performance during the pre-crisis. An explanation for the large errors stems from the limited data available up to 2007. Indeed, the 2007 EU entrants (Bulgaria and Romania) and the latest newcomer Croatia (acceded in 2013) markedly register the highest forecast errors. Their inclusion in EU aggregate may slightly influence the aggregate errors, although the size of their revenue remains fairly small as a share of total EU revenue. Consequently, all conclusions regarding this period must be drawn with due care, as the robustness of the results is very limited. As far as the economic crisis is concerned, it had a larger impact on the forecasting accuracy of the new Member States that tended to be overly optimistic in a recessionary environment.

During the post-crisis years, the precision of the projections visibly improved in most EU countries, for both the current and year-ahead forecasts. The most striking exceptions are represented by Portugal (marking its largest errors in 2011 and 2012) and Hungary (which generated, against all expectations, a record level of revenues in 2011). It is also noteworthy that, before and after the economic crisis, there is a general tendency of

under predicting government receipts across Member States, while during the recessionary period the forecasts have, on average, exceeded outturns (as illustrated in the tables A1 and A2 in Annex A).

2.2. DECOMPOSITION OF NOMINAL REVENUE ERROR

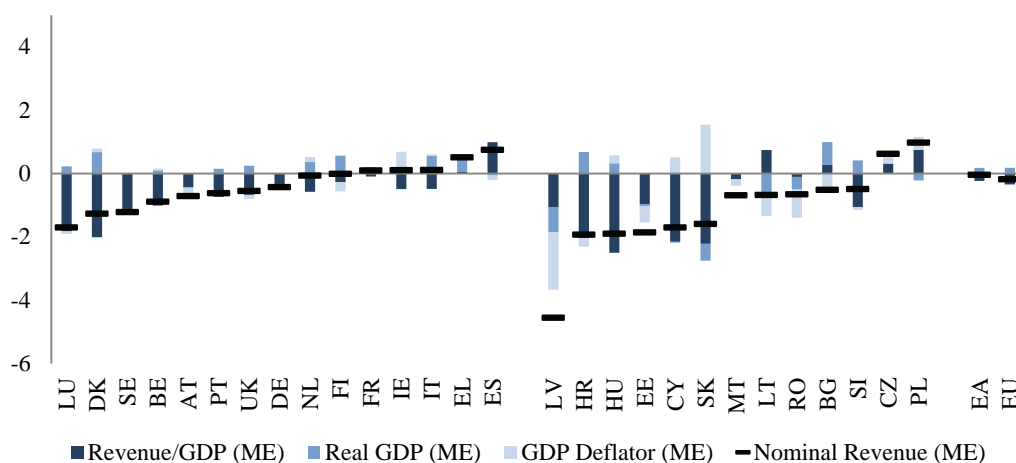
This section focuses on analysing the interconnection between the errors in real GDP, GDP deflator and revenue-to-GDP ratio on one side, and nominal revenue error, on the other. The error for the revenue-to-GDP ratio is calculated following the same methodology adopted for the other variables, with the only amendment that each estimate (forecast, first available estimate, first settled estimate and revision) is defined as the ratio between government revenue and nominal GDP.

The underestimation of revenue-to-GDP ratio tends to offset the over-estimation of real GDP, explaining a fairly low error in nominal revenue for the EU. The ME estimates for revenue-to-GDP ratio, real GDP and the GDP deflator are additive in the first order (as illustrated in Figure 5 (a), covering the current year outlook). As expected, the consistency between the nominal revenue error and the sum of its components is loosened for the new Member States, where the gap reaches almost 1 pp. for Bulgaria, Latvia and Romania. The source of this inconsistency seems to result from significant underestimation of the revenue growth (Latvia, Estonia and Malta) or of the GDP deflator (Romania and Bulgaria)⁵.

The revenue-to-GDP ratio explains around half of the forecast errors of total nominal revenue, with the other half being largely explained by real GDP and, to a lower extent, GDP inflation. While the MAE estimates are non-additive unlike ME⁶ (Figure 5 (b)), they shed new light on the weight of each variable in the overall error. For both the old and new Members States, almost half of this error is explained by misestimations in the macro indicators (with the bigger share attributable to real GDP), while the other half is the specific response of revenue to nominal GDP.

Figure 5: Decomposition of nominal revenue error⁷

(a) in ME (current year)

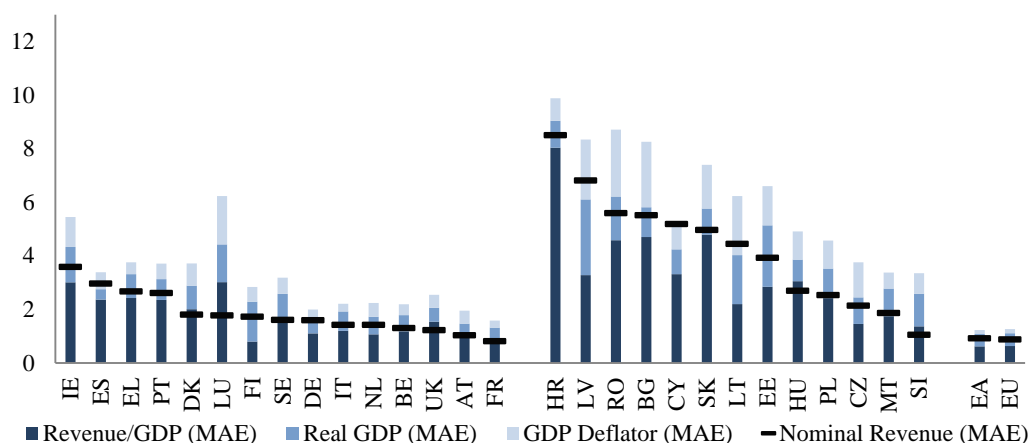


⁵ An exception of this consistency in the old Member States is represented by Ireland, which displays the largest difference between the two errors (a gap of 0.09 pp.). A possible explanation can derive from the overestimation of the GDP deflator (0.6 pp, marking the largest error in the group).

⁶ In absolute terms, the nominal revenue error is generally larger than the error for revenue-to-GDP. A particular case is represented by Luxembourg, due to a substantial overestimation of the deflator (relative to the other components).

⁷ For the decomposition of nominal revenue error, both in MA and in MAE, for the year-ahead see Figure A1 (a) and (b) in Annex A.

(b) in MAE (current year)

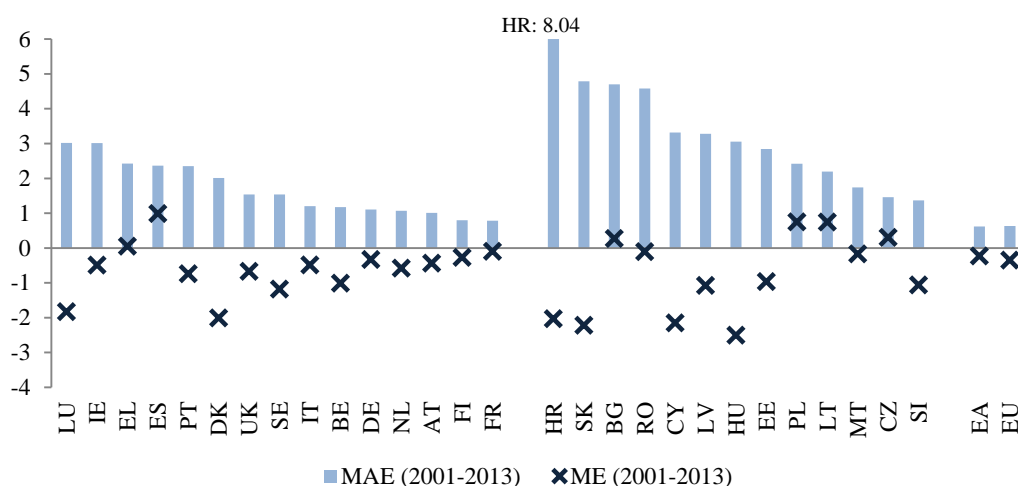


For the year-ahead forecast, the errors are larger, due to a stronger overestimation of real GDP (see Figure A1 from Annex A). The revenue-to-GDP underestimation is not offsetting the larger over-estimation in real GDP (and GDP deflators). Turning to the absolute error (MAE), the revenue-to-GDP ratio explains only between a third and half of total errors, given that GDP absolute error (and GDP deflator error) are larger compared with the current-year forecast.

2.3. FOCUS ON REVENUE-TO-GDP ERROR

The error in the change in the revenue-to-GDP ratio is far from negligible, especially at country level. While the average revenue-to-GDP error (ME) is around -0.1 p.p. of GDP for the EU, the average absolute error (MAE) is clearly higher at 0.4 p.p. The MAE is even higher for most Member States than what the EU aggregate error suggests. For ‘old’ Member States, the MAE lies between 3 pp. and 0.5 p.p, while for the ‘new’ Member States (except for Croatia), the figures are clearly higher, comprised between 5 pp. and 1.5 p.p.

Figure 6: Forecast error for revenue-to-GDP (current year)

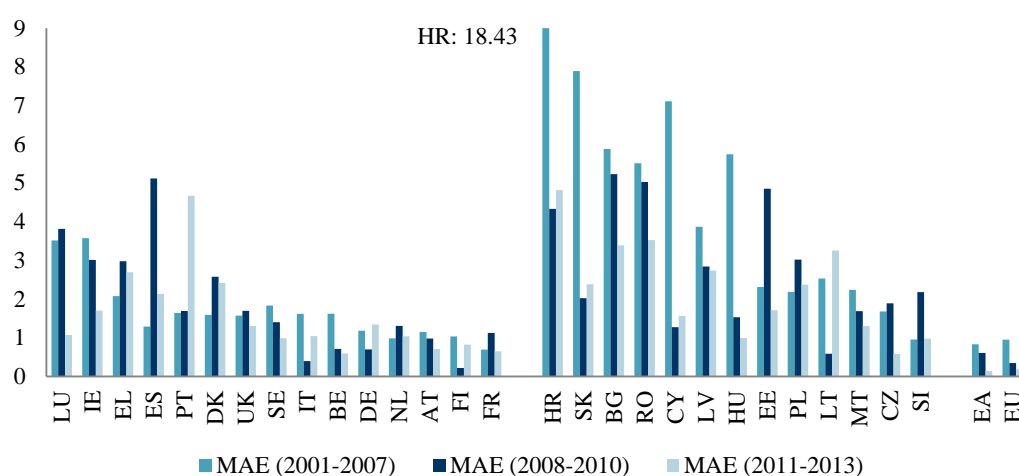


The change in revenue-to-GDP error seems to be underestimated, with the exception of very few countries. The latter are Spain, Lithuania and Poland, with an overestimation of almost 1 pp. (see ME in Figure 6). In contrast with nominal revenue growth, the sign of the error is reversed for six Member States. This is mainly due to the fact that considering the forecast error in the change in revenue-to-GDP the larger allows us to

disregard the over/under-forecasting of GDP growth or inflation, such as the over-forecasting of real GDP (Italy) or of the GDP deflator (Ireland), or the under-forecasting of GDP growth (Lithuania). In absolute terms, the usual difference between the old and the new Member States is clearly diminished (with the exception of the last EU entrants and Slovakia, which go beyond the level of 4.5 pp.).

Analysing the revenue-to-GDP error by sub-periods, the highest forecasting inaccuracy was reached in the pre-crisis years, especially in the new Member States. This confirms the analysis in terms of revenue growth. Slovakia, Cyprus and Hungary exhibit prediction errors four or five times as large compared to the subsequent periods, while Croatia reaches a striking level of 18.43 pp (caused by an under-forecasting of revenue growth of 37 pp. in 2012). This tendency is also reflected in the fairly large EU aggregate error for this period. In the crisis outbreak, the largest forecast errors were recorded by Spain, Bulgaria, Romania and Estonia (approximately 5 pp.), while in the subsequent consolidation period, Portugal, Lithuania and the latest three EU entrants displayed the poorest forecasting performance.

Figure 7: Revenue-to-GDP error by sub-period (current year)



For the autumn outlook, the size of the errors is virtually the same as in the spring forecast, especially for the new Member States (see Figure A2 in Annex A). In these countries, the revenue-to-GDP growth tends to be overestimated to a larger degree, while under-forecasting affects the old Member States, but to a smaller extent. Examining the error by sub-periods (Figure A3 from Annex A), the lowest accuracy is reported during the crisis outbreak for the old Member States (Spain reaching the largest error in the group – 5.56 pp.) and in the pre-crisis period for the new Member States. For the latter group, the forecasting performance improved during the 2008-2010 period and even more so in the subsequent consolidation period (excepting for Hungary standing out due to the 2011 underestimation of government receipts).

2.4. FORECAST ERRORS BY TAX CATEGORY

This section focuses on the prediction accuracy of the three main tax categories: indirect taxes (defined as taxes linked to production and imports), **direct taxes** (consisting of current taxes on income and wealth) **and social contributions** (which include actual and imputed social contributions)⁸.

⁸ In the ESA95 classification, these categories correspond to the following transactions: taxes on production and imports (D.2), current taxes on income and wealth (D.5) and social contributions (D.61). Figures 8 and 9 show the prediction errors for the current year by each of these categories (as ME and MAE estimates).

Figure 8: Forecast errors for indirect taxes, direct taxes and social contributions (current year)

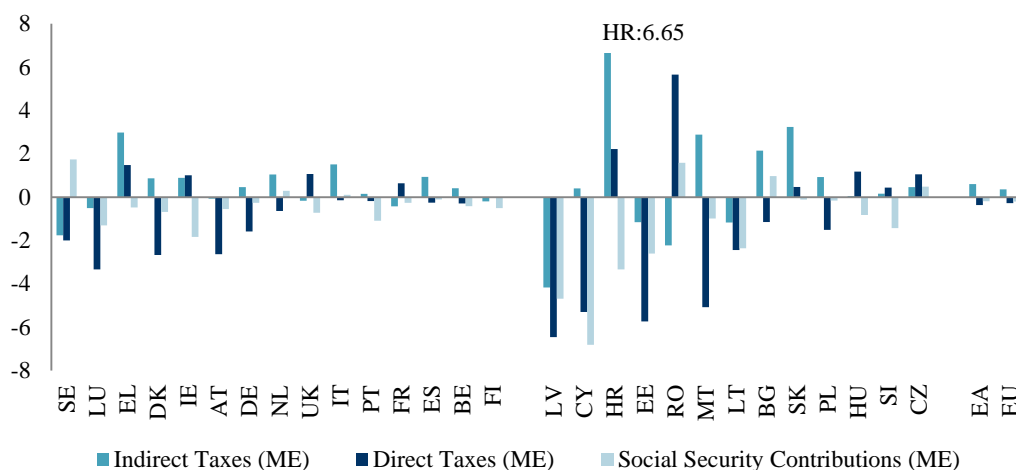
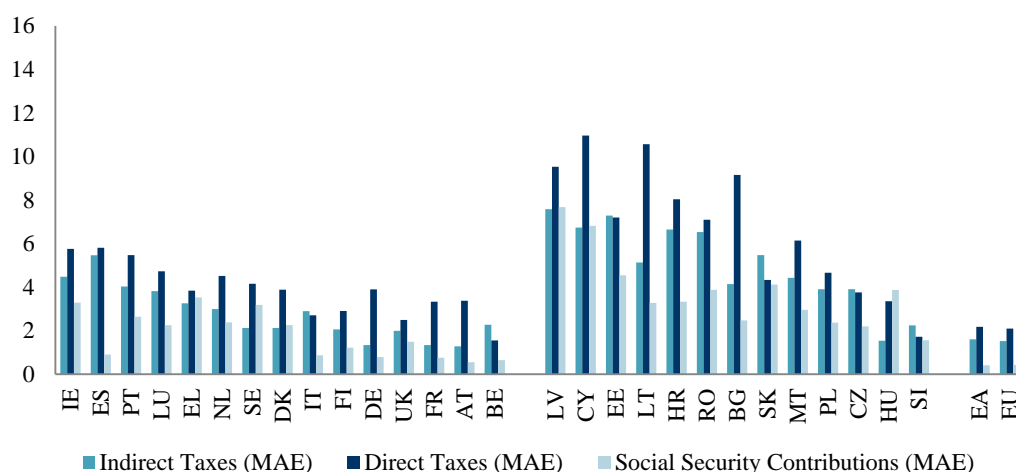


Figure 9: Forecast errors for indirect taxes, direct taxes and social contributions by sub-periods (current year)



The receipts from taxes on production and imports were over forecasted between 2001 and 2013 by most Member States. Croatia, Slovakia and Greece were the most consistent in this tendency, while Latvia, Sweden and Romania predicted revenue growths inferior to the actual outcomes. In absolute terms, the best forecasting performance is shown by Austria, France, Germany and Hungary, managing to maintain an error below 1.5 pp. On the opposite side, Latvia, Estonia, Cyprus and Romania recorded the highest errors, particularly in 2008 or 2009 when they drastically over forecasted the revenues from indirect taxes. The least accurate from the old Member States is Spain (5.47 pp.), mainly due to the same significant misestimations during the crisis years.

The forecast error for direct taxes reaches, in absolute terms, the highest levels compared to the other tax categories (with the a few exceptions where it is outrun by the prediction error for indirect taxes). The contrast is even more striking for some countries where it is twice or three times as large relative to indirect taxes and social contributions (Germany, France, Austria, Lithuania and Bulgaria). If the size of the error is quite homogenous across the old Member States (around 4 pp.), in the recently acceded countries the divergence is more obvious, going from approximately 11 pp. for Cyprus and Lithuania to 1.72 pp. for Slovenia. The error is mainly the result of constant underestimations during the observed period. Romania and Greece are some of the few countries where the projected revenues from taxes on income and wealth exceeded the actual outturns.

As opposed to direct taxes, the predictions for social security contributions display the highest forecasting accuracy. The absolute size of the error is approximately half the size of the direct taxes forecast error, reaching its peak at around 3 pp. in the old Member States (Greece, Ireland, Sweden) and 7 pp. in the new ones (Latvia and Cyprus). Similar to the forecasts for direct taxes, the predictions for social contributions are generally underrated over the analysed time frame. Sweden, Romania and Bulgaria tend, however, to be more optimistic on the net social contributions received.

The autumn forecasts reveal the same tendencies, with stronger inaccuracies for the direct and indirect taxes in the recently acceded countries. Overestimations are more often the source of prediction errors, especially in the old Member States where, in very few cases, the actual returns surpassed the forecasted receipts.

3. ACCURACY TEST AND REPRESENTATIVENESS

The analysis continues with a series of empirical tests of forecast accuracy which value added is to ascertain whether they have some desirable characteristics, such as having no inertia, being unbiased and using all available information at the time of the forecasting. In this respect four relevant hypothesis are verified. First of all, the absence of autocorrelation among errors is tested in different point in time in order to exclude an inertial effect. Bias in error is also tested to exclude a too optimistic or pessimistic behaviour of the forecaster. Whether all the information available at the time of the forecast exercise was efficiently taken into account is also considered. With some limited exceptions, described at length in what follows, the degree of uncertainty revealed by the tests seems to be minor. The tests are conducted for nominal revenue, real revenue⁹, revenue-to-GDP ratio, real GDP, indirect taxes, direct taxes and social contributions.

3.1. PERSISTENCE OF FORECASTS ERRORS

The first accuracy test aims at verifying whether there is a systematic correlation between errors, causing an “inertia” effect in the forecast. In the absence of correlation, indeed, it can be concluded that the error made in a previous year does not feed into the error made in subsequent(s) year(s). With this objective, a three-lags autocorrelation test is performed using a Ljung-Box Q test (see Annex B), which null hypothesis is that the data are independently distributed¹⁰ (i.e. the correlation in the population from which the sample is taken is zero and thus any observed correlation is due to randomness of the sampling process).

Based on the test results the autocorrelation of forecast errors does not seem to be a major issue in the European Commission forecast. Indeed, at the EU level, there are no cases of persistence in forecast errors. The situation is slightly different when considering the euro area, where serial correlation is found for direct taxes in the current year outlook.

At country level, for the current-year forecasts, the test results point to only very limited cases of autocorrelation, evenly distributed between the old and the new Member States. The forecast errors are significantly correlated for up to two or three periods for the German nominal revenue, direct taxes and social contributions, Greek real GDP, Irish social contributions, Hungarian revenue/GDP and Polish direct taxes. Persistence of forecast errors is also found for nominal revenue in Austria, Hungary and Latvia, for real GDP in Ireland, and for direct taxes in Slovakia.

The results for the year-ahead forecasts are even more satisfactory, displaying fewer cases of autocorrelation in the forecast errors. Serial correlation of up to three periods is found only for the Greek real GDP, Lithuanian revenue/GDP and the Swedish social contributions. Other instances of error persistence are identified for the Irish social contributions and the Austrian indirect taxes.

3.2. UNBIASEDNESS TEST

It is useful to test the existence of a possible bias of Commission revenue forecast, corresponding to the presence of a systematic optimistic or pessimistic pattern. Forecasts from public national or international institutions may be distorted by the willingness of avoiding adverse self-fulfilling prophecies by informing expectation on the upside¹¹. In this respect the bias of the revenue projection can be tested simply regressing the

⁹ The real revenue is calculated as the ratio between URTG and PVGD.

¹⁰ A p-value below 0.05 indicates that the null hypothesis of absence of autocorrelation in the forecast errors is rejected at the 5% level of significance.

¹¹ See for instance Frankel and Schreger (2013) for pointing out an optimistic view.

error on a constant, assuming ε to be a zero-mean normally distributed residual term¹². In models with only the intercept, the constant is equal to the mean of the dependent variable.

$$e_{t,t} = \alpha + \varepsilon_t \text{ for the current year (1)}$$

$$e_{t+1,t} = \alpha + \varepsilon_{t+1} \text{ for the year-ahead (2)}$$

The null hypothesis $H_0: \alpha=0$ is then tested with a Student t-test. A p-value below 0.05 would imply the occurrence of a bias.

Looking at the results for the seven variables, the Commission's forecasts do not appear biased at aggregate level. Table 3 presents the unbiasedness test results for nominal revenue, direct and indirect taxes and social contributions. Detailed results for all seven variables are presented in Annex B. At the aggregated level, the outlook does not display any presence of bias.

Table 3: Bias in forecast errors

Member State	Nominal revenue				Indirect taxes				Direct taxes				Social contributions			
	current year		year-ahead		current year		year-ahead		current year		year-ahead		current year		year-ahead	
	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$	α	Signif. $\alpha=0$
AT	-0.71	0.04*	-0.67	0.34	-0.07	0.88	-0.06	0.88	-2.63	0.04*	-0.58	0.78	-0.55	0.01*	-0.42	0.13
BE	-0.89	0.04*	-0.36	0.6	0.41	0.64	0.41	0.68	-0.29	0.65	0.06	0.96	-0.42	0.04*	-0.72	0.06
DE	-0.43	0.41	0.21	0.79	0.46	0.3	0.63	0.4	-1.58	0.21	-0.07	0.97	-0.26	0.32	0.38	0.34
DK	-1.27	0.07	-0.16	0.83	0.87	0.26	0.44	0.67	-2.67	0.06	-0.48	0.59	-0.68	0.43	3.1	0.03*
EL	0.51	0.62	1.13	0.48	2.98	0.02*	4.27	0.04*	1.48	0.35	2.48	0.14	-0.48	0.69	0.83	0.58
ES	0.75	0.53	1.05	0.52	0.93	0.65	2.87	0.26	-0.25	0.91	-0.16	0.95	-0.1	0.75	0.17	0.8
FI	-0.01	0.99	0.05	0.96	-0.2	0.76	-0.22	0.84	-0.02	0.98	1.09	0.53	-0.51	0.25	0.1	0.88
FR	0.1	0.74	0.29	0.65	-0.42	0.37	0.38	0.55	0.64	0.63	0.36	0.86	-0.26	0.31	-0.3	0.33
IE	0.11	0.94	1.51	0.46	0.89	0.63	2.11	0.41	1.01	0.66	2.24	0.47	-1.84	0.08	0.61	0.72
IT	0.11	0.84	0.41	0.54	1.51	0.13	1.58	0.16	-0.14	0.89	0.25	0.85	0.11	0.74	0.06	0.89
LU	-1.7	0.00*	-1	0.21	-0.51	0.7	1.26	0.52	-3.33	0.03*	-4.04	0.01*	-1.3	0.09	-1.48	0.03*
NL	-0.06	0.91	0.53	0.61	1.04	0.29	1.07	0.46	-0.64	0.7	0.63	0.77	0.29	0.72	0.92	0.43
PT	-0.62	0.51	0.01	1	0.15	0.92	2.62	0.15	-0.18	0.93	-0.03	0.99	-1.09	0.39	-0.33	0.73
SE	-1.22	0.01*	-0.22	0.71	-1.76	0.03*	-0.86	0.15	-2	0.12	-0.17	0.91	1.74	0.2	0.81	0.57
UK	-0.55	0.17	0.12	0.9	-0.16	0.83	0.64	0.5	1.07	0.28	1.51	0.3	-0.72	0.18	-0.17	0.76
BG	-0.51	0.85	1.51	0.75	2.15	0.33	2.86	0.56	-1.14	0.85	0.2	0.98	0.97	0.43	3.03	0.31
CY	-1.7	0.46	0.67	0.81	0.41	0.9	3.43	0.44	-5.3	0.31	-2.26	0.71	-6.82	0.00*	0.46	0.81
CZ	0.62	0.45	1.88	0.12	0.46	0.75	3.11	0.03*	1.05	0.46	1.52	0.52	0.48	0.63	2.06	0.23
EE	-1.86	0.23	-2.19	0.33	-1.15	0.66	-1.33	0.71	-5.73	0.01*	0.37	0.93	-2.6	0.14	-2.89	0.28
HR	-1.93	0.73	3.21	0.26	6.65	0.33	-	-	2.22	0.83	-	-	-3.33	0.22	-	-
HU	-1.9	0.1	-1.97	0.54	0.05	0.93	-0.42	0.84	1.18	0.52	3.86	0.23	-0.82	0.55	0.17	0.93
LT	-0.67	0.68	-0.5	0.88	-1.17	0.54	-1.26	0.74	-2.44	0.62	-1.26	0.87	-2.36	0.16	-2.19	0.22
LV	-4.55	0.07	-5.54	0.2	-4.17	0.19	-5.02	0.31	-6.45	0.05*	-6.18	0.36	-4.68	0.08	-3.71	0.4
MT	-0.69	0.4	-1.32	0.33	2.89	0.11	0.38	0.76	-5.08	0.04*	-2.33	0.4	-0.98	0.45	-1.45	0.32
PL	0.98	0.26	0.72	0.58	0.93	0.51	0.82	0.71	-1.51	0.4	-4.64	0.17	-0.16	0.85	-0.47	0.78
RO	-0.65	0.81	1.41	0.75	-2.23	0.51	-0.69	0.89	5.65	0.04*	7.26	0.29	1.59	0.49	2.16	0.52
EA	0.2	0.63	0.39	0.58	0.89	0.2	1.29	0.18	-0.17	0.84	-0.03	0.99	0.03	0.9	0.16	0.63
EU	0.27	0.52	0.55	0.58	0.89	0.19	1.16	0.31	0.01	0.99	0.83	0.59	0.24	0.55	0.28	0.59

Note: significant p-values in grey shaded cells

The forecasts at country level seem to have systematically underestimated government revenues in a very limited number of countries during the current-year exercise (in Belgium, Luxembourg and Sweden), while no bias was identified for the year-ahead forecasts. Looking deeper at the current-year exercise, some tax categories were affected by a forecasting base: indirect taxes (in Sweden), direct taxes (in Austria, Estonia, Luxembourg, Latvia and Malta) and social contributions (in Austria, Belgium, Cyprus and Slovenia). A positive bias is noted in Greece (for indirect taxes) and in Romania (for the taxes on income and wealth). Turning to the year-ahead forecasts, fewer instances of bias are observed and they are more balanced as far as their sign is concerned. The taxes linked to import and production are overestimated in the Czech Republic and, again, in Greece. Luxembourg undervalues once more the direct taxes, as well as social contributions. A particular case is represented by the forecast error for nominal revenue in Austria, where the bias appears to originate from a problem of serial correlation. This suggests that rather than being systematically pessimistic about government revenue, errors (once made) seem likely to persist.

¹² A further exercise can be based on cutting the sample in two halves in order to verify possible hidden biases.

3.3. EFFICIENCY TESTS

Forecasts are considered efficient if all information available at the time of the forecast was fully exploited. There are different ways to test for efficiency. Among those, the following tests have been selected:

3.3.1. Weak efficiency

One way to test for efficiency, called weak efficiency test, is regressing the forecast error on a constant and on the lagged forecast error, i.e.

$$e_{t,t} = \alpha + \beta e_{t-1,t-1} + \varepsilon_t \text{ for the current year (3)}$$

$$e_{t+1,t} = \alpha + \beta e_{t,t-1} + \varepsilon_t \text{ for the year-ahead (4)}$$

A low probability value for the joint F-test (i.e. < 0.05) would suggest that the forecast is correlated with its error and that the forecast could thus be improved by exploiting this information. The results are presented in Table 4 below.

Overall, the forecasts appear to be efficient at the aggregated level and for most individual countries, with some exceptions regarding the current year projections mainly. The null hypothesis of weak efficiency is rejected for Germany (nominal revenue, direct taxes and social contributions), Malta (indirect taxes) and Poland (direct taxes). The Greek forecasts for real GDP and the Irish projections for social contributions, however, seem inefficient both in the current year and the year-ahead exercise.

Table 4: Weak efficiency test

	Nominal revenue		Real GDP		Indirect taxes		Direct taxes		Social contributions	
	current year	year ahead	current year	year ahead	current year	year ahead	current year	year ahead	current year	year ahead
	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$	Signif. $\beta=0$
AT	0.08	0.90	0.48	0.73	0.52	0.06	0.43	0.90	0.34	0.74
BE	0.22	0.54	0.72	0.41	0.23	0.24	0.84	0.76	0.89	0.74
BG	0.29	0.94	0.45	0.33	0.43	0.59	0.36	0.59	0.95	0.93
CY	0.75	0.48	0.08	0.45	0.96	0.82	0.64	0.67	0.43	0.16
CZ	0.65	0.73	0.42	0.72	0.74	0.11	0.59	0.92	0.98	0.75
DE	0.01	0.34	0.29	0.72	0.69	0.70	0.01	0.15	0.03	0.66
DK	0.20	0.85	0.81	0.69	0.17	0.30	0.18	0.59	0.83	0.85
EE	0.76	0.77	0.19	0.16	0.26	0.91	0.14	0.41	0.18	0.51
EL	0.30	0.86	0.03	0.00	0.98	0.91	0.90	0.51	0.77	0.52
ES	0.42	0.18	0.37	0.59	0.78	0.22	0.32	0.36	0.06	0.08
FI	0.82	0.49	0.66	0.70	0.48	0.85	0.92	0.62	0.76	0.82
FR	0.52	0.91	0.46	0.63	0.86	0.55	0.92	0.56	0.31	0.87
HR	0.94	0.70	0.45	0.67	-	-	-	-	-	-
HU	0.12	0.55	0.83	0.63	0.61	0.92	0.96	0.44	0.32	0.95
IE	0.21	0.19	0.07	0.60	0.27	0.22	0.31	0.16	0.03	0.05
IT	0.58	0.94	0.48	0.65	0.71	0.90	0.54	0.82	0.91	0.94
LT	0.69	0.98	0.51	0.74	0.71	0.95	0.98	0.84	0.71	0.39
LU	0.53	0.38	1.00	0.41	0.84	0.45	0.71	0.43	0.15	0.22
LV	0.09	0.52	0.22	0.26	0.90	0.55	0.43	0.98	0.31	0.52
MT	0.13	0.08	0.79	0.58	0.05	0.70	0.33	0.83	0.63	0.29
NL	0.69	0.86	0.20	0.70	0.51	0.61	0.23	0.45	0.63	0.95
PL	0.52	0.59	0.91	0.79	0.88	0.84	0.02	0.25	0.47	0.68
PT	0.25	0.32	0.70	0.45	0.72	0.77	0.52	0.84	0.44	0.80
RO	0.82	0.80	0.53	0.84	0.78	0.71	0.90	0.84	0.98	0.66
SE	0.60	0.45	0.89	0.79	0.33	0.83	0.19	0.44	0.17	0.02
SI	0.52	0.96	0.90	0.90	0.86	0.54	0.67	0.31	0.37	0.55
SK	0.84	0.17	0.56	0.94	0.28	0.66	0.10	0.82	0.96	0.97
UK	0.59	0.30	0.79	0.62	0.84	0.90	0.58	0.65	0.33	0.28
EA	0.30	0.71	0.68	0.74	0.79	0.51	0.11	0.68	0.85	0.60
EU	0.12	0.85	0.28	0.73	0.34	0.74	0.81	0.74	0.97	0.63

Note: Signif. $\alpha=0$, $\beta=0$ denotes the p-value for the $\alpha=0$, $\beta=0$ F-test. Significant values in grey shaded cells.

3.3.2. Informational efficiency

As a complement to the weak efficiency test, one can also control for the importance of the past outcome, i.e. check whether the forecast errors can be predicted by past realisations. Therefore, for the current year, the forecast error is regressed on the lagged realisation:

$$e_{t,t} = \alpha + \beta y_{t-1} + \varepsilon_t \quad (5)$$

while for the year-ahead outlook the second lag of the realisations is used¹³:

$$e_{t+1,t} = \alpha + \beta y_{t-2} + \varepsilon_{t+1} \quad (6)$$

The null hypothesis is H0: $\beta = 0$.

The past outcome was overall very well incorporated in the forecast and the rare exceptions are not overlapping the ones coming out of the weak efficiency test. As for the current year, the realisations could have been better exploited when estimating the forecast errors for: nominal revenue (in Malta and Romania), indirect taxes (in Belgium and Hungary) and social contributions (in Spain and Slovakia). Only in three instances the past outcome could have been reflected to a greater degree in the year-ahead forecasts: the Portuguese nominal revenue, the German indirect taxes and the Spanish social contributions.

Table 5: Informational efficiency test

	Nominal revenue				Indirect taxes				Direct taxes				Social contributions			
	current year		year-ahead		current year		year-ahead		current year		year-ahead		current year		year-ahead	
	β	Signif.	β	Signif.	β	Signif.	β	Signif.	β	Signif.	β	Signif.	β	Signif.	β	Signif.
AT	-0.03	0.87	0.47	0.18	-0.21	0.59	0.11	0.7	0.22	0.26	0.38	0.21	-0.22	0.22	0.25	0.47
BE	0.13	0.48	0.09	0.8	0.51	0.02*	-0.21	0.56	0.09	0.61	0.16	0.63	-0.14	0.3	0.19	0.59
BG	-0.14	0.71	0.45	0.4	0.42	0.08	-0.01	0.98	-0.12	0.79	0.44	0.4	0.13	0.46	0.44	0.27
CY	-0.12	0.7	-0.02	0.97	-0.13	0.7	0.04	0.91	-0.23	0.47	0.21	0.55	-0.09	0.72	0.31	0.44
CZ	0.16	0.48	0.19	0.5	0.17	0.69	0	0.99	-0.05	0.87	-0.17	0.62	0.15	0.51	0.27	0.44
DE	-0.11	0.64	0.44	0.34	0.1	0.54	0.56	0.04*	-0.25	0.23	-0.05	0.89	0.07	0.79	-0.31	0.63
DK	0.13	0.64	0.09	0.78	-0.24	0.33	0.06	0.87	0.36	0.4	0.08	0.83	0.03	0.86	-0.03	0.89
EE	-0.06	0.77	0.37	0.21	0.21	0.49	0.08	0.82	-0.24	0.12	0.5	0.07	-0.11	0.6	0.29	0.41
EL	-0.02	0.94	-0.06	0.91	0.19	0.32	-0.11	0.81	-0.15	0.68	-0.01	0.98	0.06	0.75	0.19	0.63
ES	-0.19	0.37	0	1	0.19	0.45	-0.12	0.69	-0.31	0.18	0.1	0.75	-0.18	0.01*	-0.39	0.04*
FI	0.21	0.21	0.27	0.43	0.24	0.24	0.32	0.5	0.2	0.21	0.28	0.38	-0.21	0.17	0.11	0.7
FR	0.04	0.73	0.12	0.69	0.38	0.08	0.09	0.78	-0.02	0.93	0.05	0.89	0.25	0.19	0.45	0.13
HR	-0.39	0.62	0.29	0.5	2.75	-	-	-	0.99	-	-	-	-3.49	-	-	-
HU	0.03	0.82	0.31	0.57	0.33	0.03*	-0.11	0.77	-0.16	0.31	0.26	0.42	0.22	0.27	0.25	0.36
IE	-0.21	0.33	0.12	0.71	-0.08	0.69	0.1	0.72	-0.17	0.48	0.22	0.55	-0.12	0.41	-0.48	0.06
IT	0.03	0.89	0.41	0.15	0.11	0.71	0.46	0.17	-0.15	0.44	0.13	0.6	-0.2	0.18	0.17	0.48
LT	0.09	0.59	0.19	0.57	0.34	0.06	0.38	0.28	0	0.99	0.06	0.87	-0.34	0.08	0.03	0.89
LU	0.22	0.3	0.29	0.41	0.23	0.33	0.5	0.14	0.28	0.43	-0.16	0.58	0.33	0.27	-0.38	0.06
LV	-0.06	0.73	0.37	0.19	0.22	0.34	0.44	0.16	-0.02	0.91	0.34	0.27	-0.01	0.95	0.52	0.06
MT	-0.23	0.04*	-0.43	0.35	0.43	0.17	0	1	-0.01	0.97	0.42	0.39	0.34	0.35	0.4	0.29
NL	0.03	0.89	-0.26	0.47	0.24	0.34	-0.21	0.63	-0.01	0.97	0.61	0.22	0	0.98	-0.15	0.5
PL	0.1	0.72	0.18	0.56	0.29	0.31	0.23	0.61	-0.38	0.07	0.08	0.79	0.14	0.62	0.28	0.53
PT	0.08	0.63	0.8	0.04*	0	0.99	0.13	0.7	0.34	0.14	0.59	0.08	-0.16	0.62	-0.74	0.06
RO	0.31	0.02*	0.32	0.51	0.48	0.16	0.3	0.51	-0.14	0.41	0.38	0.32	0.03	0.91	-0.08	0.8
SE	0.28	0.11	0.01	0.99	0.08	0.78	0.3	0.1	0.26	0.23	0.15	0.55	0.53	0.07	-0.05	0.91
SI	0.03	0.82	0.07	0.83	0.05	0.88	-0.13	0.71	-0.14	0.27	-0.28	0.5	-0.31	0.00*	-0.19	0.66
SK	-0.47	0.23	-0.15	0.65	0.18	0.51	0.24	0.44	0.04	0.83	0.07	0.82	0.02	0.97	0.24	0.58
UK	0.02	0.83	0.01	0.96	0.28	0.07	0.23	0.3	0.03	0.89	0.1	0.74	0.25	0.06	-0.12	0.52
EA	0.08	0.64	0.38	0.26	0.22	0.34	0.27	0.42	-0.12	0.55	0.35	0.28	0.07	0.48	0.11	0.7
EU	0.13	0.37	0.34	0.31	0.33	0.06	0.3	0.36	-0.04	0.8	0.34	0.29	0.18	0.49	0.23	0.49

Note: Signif. $\beta=0$: p-value of the $\beta=0$ t-test. Significant values in grey shaded cells.

Overall, the empirical tests of forecast show that the European Commission forecasts, as far as revenue related variables are concerned, are not affected by biases or efficiency problems. This general conclusion, valid for

¹³ The first estimate of the fourth quarter National Accounts of the previous year is available only in the first quarter of the following year.

most countries, may be nuanced when looking at specific Member States for specific tax variables and forecast horizon (current year/the year-ahead) and the variable considered.

3.4. CHECKING THE REPRESENTATIVENESS OF COMMISSION REVENUE FORECAST: A COMPARISON WITH OECD FORECASTS

This sub-section aims to compare the performance of EU revenue forecasts with that of OECD to show that the EU forecast performs as well as another mainstream forecast. The purpose is to suggest that the Commission forecast can be used as a representative forecast of public revenue, illustrating the difficulties and uncertainty inherent to any enterprise aiming at predicting revenue ex ante rather than pointing to specific forecasting errors by a given institution.

To this end, we compare statistics of ME, MAE and RMSE obtained from Commission and OECD forecasts for euro area countries. Using the euro area countries allows for a perfect overlap in the country coverage between OECD forecast and European Commission forecast. The analysis covers the nominal revenue¹⁴ and looks at the overall period 2003-2013¹⁵ along with three sub-periods (2003-2007, 2008-2010 and 2011-2013) to take into account the effect of the crisis. Both the current-year and year-ahead data are considered and the same methodology is applied to the EC and OECD vintages. It worth anticipating that, to some extent, the differences between the forecasts of the two institutions can be explained by the fact that the month in which the forecast is concluded may slightly differ.¹⁶

At euro area level the difference between the EC and OECD statistics are minor, in particular with current year forecast. This is shown in Table 6. Not only is the MAE (and RMSE) almost identical, but also the Commission forecast seems more accurate when measured with ME, suggesting that the errors of different signs are offsetting each other over time. At the same time, forecasts in the year-ahead by OECD seem slightly more performant, although broadly comparable, according to all criteria.

Table 6: Euro area statistics (ME, MAE and RMSE) for EC and OECD, current year and year-ahead.

	ME OECD	ME EC	ME difference	Period
EA	-0.56	-0.08	0.48	current year
	-0.01	0.26	0.28	year-ahead
	MAE OECD	MAE EC	MAE difference	
	0.98	0.99	0.01	current year
	1.62	1.80	0.18	year-ahead
	RMSE OECD	RMSE EC	RMSE difference	
	1.28	1.29	0.01	current year
	2.23	2.62	0.39	year-ahead

There is no clear pattern emerging from the comparison of country-specific forecast errors between OECD and EC, except that there are fairly similar with slightly larger gap in new Member States. Figure 10 confirms that the average errors have generally the same sign. There is no systematic better performance of OECD and EC forecast, as shown in Figure 11. This is further seen when considering the aggregate forecast error, identical between the two institutions at the euro area level. The highest differences between the two sets of forecasts are registered, both in the case of the current year and the year-ahead data, for the new Member States¹⁷ (Figure 13-15). There again, the comparison of accuracy varies from country to country, with revenue

¹⁴ The variables considered are, respectively, for the EC the "Total revenue, general government" (URTG) and for the OECD the "Total receipts, general government" (YRGT) as extracted from the "OECD Annual Projection" and "Annual projections for OECD Countries" both for autumn (November or December) and for spring (May or June).

¹⁵ As the OECD's vintages for this variable are, indeed, limited to the 2003-2013 period.

¹⁶ Indeed, for the European Commission in most of the cases the autumn (spring) forecast is concluded in late October early November (April or May), whereas for the OECD between November and December (May or June).

¹⁷ The OECD considers only 6 new Member States: Czech Republic, Estonia, Hungary, Poland, Slovenia and Slovakia.

for Estonia, Poland, Czech Republic and Slovakia better forecast by the EC, while the opposite is true for Hungary and Slovenia.

Figure 10 -12: Member States statistics (ME, MAE and RMSE) for EC and OECD, current year.

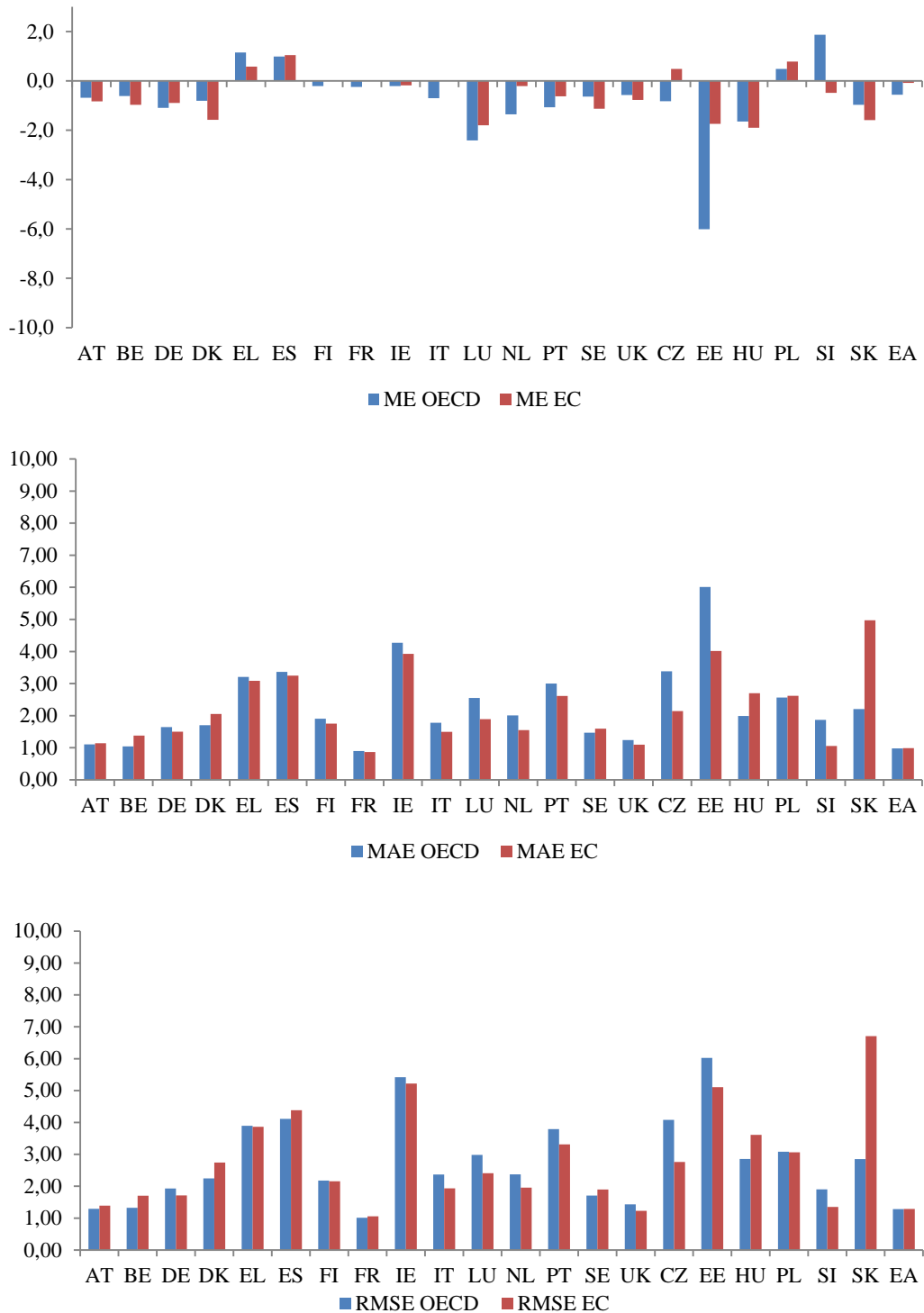
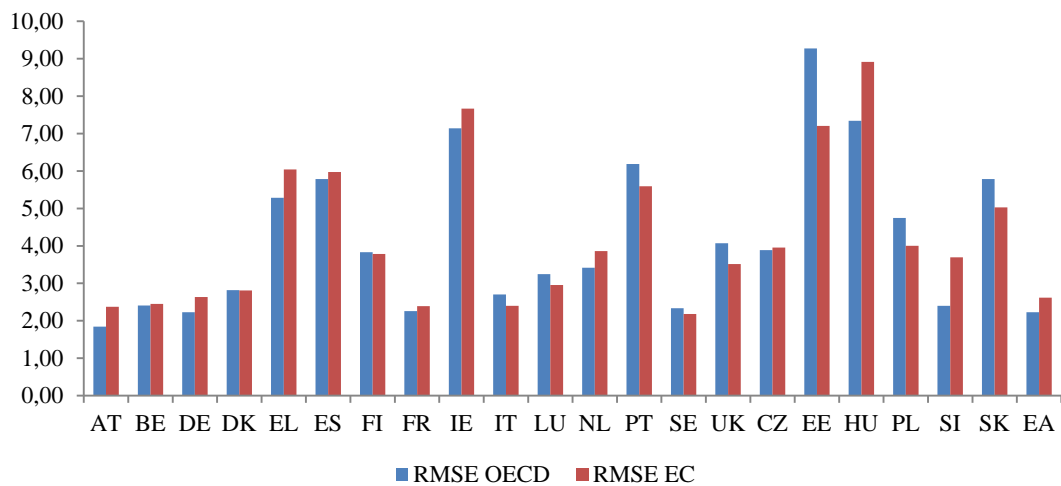
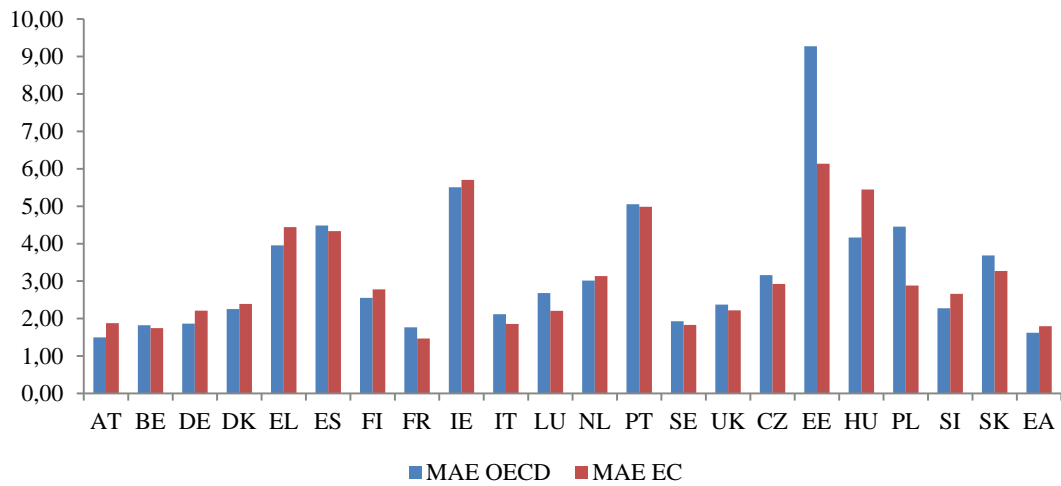
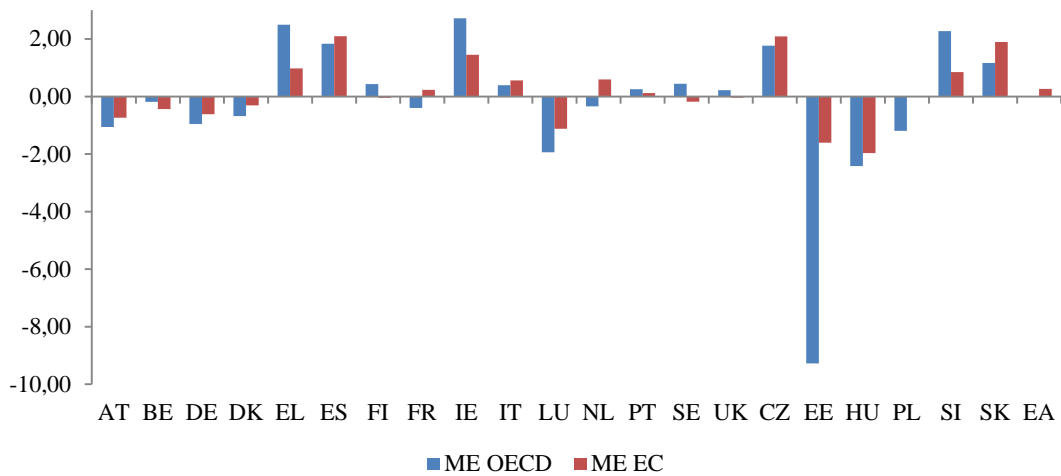


Figure 13 -15: Member States statistics (ME, MAE and RMSE) for EC and OECD, year-ahead.



A closer scrutiny to the sub periods shows that EC tends to perform better than OECD both in the period preceding and following the crisis. This closer look is based on the detailed tables in Annex C. In the crisis period the results are mixed.

4. WHAT DRIVES THE REVENUE FORECAST ERROR?

4.1. REVIEWING THE POSSIBLE DETERMINANTS OF FORECAST REVENUE ERROR

The determinants of revenue forecast error are numerous and, by type of effect, they can be grouped under the categories of: (i) non-revenue components and (ii) characteristics of the economy and fiscal policy. The aim of this sub-section is that of describing the possible determinants of revenue forecast errors in order to use the relative variables in an econometric exercise.

4.1.1. Forecast errors in underlying macroeconomic variables

A first set of determinants of the prediction error of the government nominal revenue includes the forecast error for real GDP and the forecast error for the GDP deflator. The forecast error for real GDP was widely documented by the European Commission (Keereman, 1999; Melander *et al.*, 2007; González Cabanillas and Terzi, 2012). It is expectedly a source of error in revenue forecasting since the former directly depend on economic activities. Likewise, the forecast error for the GDP deflator is a relevant cause for error in revenue forecasting, since revenues are expressed in nominal terms and are, therefore, influenced by the level of inflation. This is also reflected in the literature on fiscal drag¹⁸. The forecast errors for both indicators are computed according to the methodology described at the beginning of the paper.

4.1.2. Characteristics of the economy and fiscal policy

In addition to the components of the error, a series of external factors related to the domestic economy may influence the accuracy of the predictions for government receipts. These determinants can be further divided into two categories: variables expressed in level and variables expressed in rate of growth.

a) Variables in Levels

Size of government. The size of government, conventionally measured by the ratio of public expenditure to GDP, may be a factor related to the error in forecasting revenue. The larger the government, the larger the revenue needed to finance it. In turn, the size of total revenue may influence the size of the revenue error. One channel may be that it is potentially more complex to predict total revenue when there are very numerous revenue items at stake, with possibly different elasticities. However, the opposite argument could be put forward, namely the fact that the error in forecasting the disaggregated items may, at least partly, offset each other. The limited empirical evidence in the literature justifies an empirical investigation, conducted in this paper. The data for total government expenditure stems from the Eurostat database.

Openness of the economy. An open country is more exposed to external shocks, such as the contraction of the trade balance, which may affect the revenues (raised imported goods). For openness of the economy the literature suggests that one way to proximate its effect is to use the GDP share of exports. The data are once again extracted from Eurostat.

Tax compliance. A low tax compliance may affect the predictability of the revenue, since a large proportion of economic agents may adopt tax evasion strategy or belong to the shadow economy. Sancak *et al.* (2010) show that the non-compliance behaviours increase with the business cycle, because of the large share of liquidity-constrained household in recession or slow growth period, which explains why VAT collection is reduced in adverse economic conditions. The VAT gap indicator (also known as VAT compliance gap) is used as a proxy to measure the extent of non-compliance in the economy, given the large share of VAT in total revenue in many EU countries. The VAT gap is defined as the difference

¹⁸ I.e. the impact of inflation on revenue increase due to the untimely update of the tax bracket.

between the theoretical VAT liability and the collections of VAT. The panel data is, however, unbalanced as it covers only 26 Member States and does not include the most recent years (the last observed year is 2011). The estimates for tax compliance are taken from CASE/CPB report (2012).

Business cycle. Sancak *et al.* (2010) point out that a negative output gap may reduce the VAT collection more than proportionally, not only because of the aforementioned tax compliance effects but also owing to a deformation of the consumption pattern away from luxury goods (taxed at VAT standard rates) toward primary goods (often taxed at reduced rate). However, as shown in Mourre *et al.* (2014), the output gap seems to be weakly correlated with the elasticities of tax revenue to tax base. As an indicator of the business cycle, we take the annual output gaps computed by the European Commission (Ameco database). The output gap is measured as the percentage difference between actual GDP in constant prices and estimated potential GDP.

b) Variables in rate of growth

GDP short-term decomposition. Some GDP components are "job richer", compared to others. For instance, exports are deductible from VAT, while domestic consumptions (of both nationally produced and imported goods) are subject to VAT. Therefore, we use two variables to encapsulate some relevant characteristics of GDP short-term decomposition. One is the annual growth in private final consumption expenditure, deriving from the Eurostat database and referring to all consumer goods and services purchased directly by households for individual consumption. The second is the growth rate of exports, which are based on Eurostat and considered as "tax poor". In addition, we have added the change in the adjusted wage share as a control, since the wage bill is generally meant to be more volatile than the other tax bases. The variable is taken from DG ECFIN's Ameco database and measures the compensation per employee as percentage of GDP at market prices.

Discretionary tax policy. The occurrence of new policy measures in the area of taxation may influence the error in revenue. The direction of the effect is not clear. On the one hand, one can argue that discretionary tax measures face the issue of measuring their ex post impacts (including behavioural effects). On the other hand, discretionary tax policies, that is the new measures, are documented in detail by government in the budget law and may be easier to forecast than the spontaneous developments in the revenue (in a no-policy change scenario). Therefore, there is a need to estimate their specific impact empirically. Discretionary tax policies are measured for personal income tax, corporate income tax and VAT by the absolute value of the annual growth rates in the tax rates. For personal and corporate income tax, the rate chosen is the top rate, in order to get a time series for each country. For VAT, the standard rate is used. The data are taken from EC taxation trends report (2014). An aggregate indicator of overall discretionary measures is also computed, by averaging the growth rate in the tax rate across the three types of tax. Both the aggregate and disaggregated measures are used in the paper. These measures of discretionary reforms are not taking into account the policy affecting the tax bases and tax expenditures, for which it is difficult to find available or comparable time series across countries. While this measure remains crude, similar proxies are employed in the literature (see Price *et al.*, 2014).

House price index. This variable may be related to the revenue windfall or shortfall generated by the asset prices movements (in the housing markets). The recent economic and financial crisis has shown that this type of revenue were difficult to predict. An example is the VAT collected on new building or transaction tax on immovable property. In countries with wealth taxation and updated recurrent taxation on immovable property, the increase in the index is likely to be associated with extra revenue. The index measures the changes in the transaction prices of dwellings purchased by households. However, it is not available for Poland and it covers an incomplete time series (9 years), generating an unbalanced panel.

Share price index. The inclusion of this variable follows the same reasoning as above. It may apply for instance to stamp duties paid on shareholding. The data comes from OECD and is reported for only 22 Member States.

4.2. THE EMPIRICAL APPROACH: A PANEL DATA ANALYSIS

This subsection explains the estimation strategy used to empirically test how the determinants described in the previous paragraphs impact on the prediction of government revenue.

The choice of panel data analysis derives from the limited time series for each Member State. Running a pooled time series estimation increases the number of observations and degrees of freedom, allowing for better inference and providing more efficient estimators. The panel is unbalanced as data are starting later for some countries.

Table 7: Summary statistics on the variables of interest.

VARIABLES	N	n	mean	sd	min	max
Forecast error for nominal revenue	325	28	-0.679	4.359	-37.07	12.44
Forecast error for GDP deflator	358	28	-0.0719	1.508	-6.342	6.937
Forecast error for real GDP	358	28	0.0968	1.543	-4.484	8.374
Size of government	363	28	45.21	6.313	33.2	65.5
Openness of the economy	363	28	56.77	29.35	19.3	181.8
Tax compliance	286	26	1.647	1.311	0	7.9
Business cycle	361	28	-0.0121	3.394	-12.58	12.39
GDP short-term decomposition						
Private consumption (growth rate)	363	28	4.853	6.283	-20.61	33.07
Adjusted wage share (growth rate)	364	28	-0.131	2.931	-18.71	10.1
Exports (growth rate)	363	28	6.785	10.4	-26	71.91
Discretionary tax measures	364	28	2.63	4.811	0	32
Personal income tax (growth rate)	364	28	2.941	8.363	0	60
Corporate income tax (growth rate)	364	28	3.532	7.999	0	46.43
Standard VAT (growth rate)	364	28	1.417	4.336	0	30
House price index	201	27	101.6	15.75	64.2	179.2
Share price index	286	22	103.6	41.2	22.9	297.8

For our analysis on the possible determinants of the forecast error in nominal revenue (NR_{it}) we use the following fixed-effect specification:

$$NR_{it} = \alpha + \sum_{k=1}^K a_k X_{kit} + \sum_{z=1}^Z b_z Y_{zit} + \varepsilon_{ij} \quad (7)$$

Where X are k variables representing the non-tax components of revenue forecast error, while Y_z are z variables capturing the specific characteristics of the economy. The summary statistics for the dependent variable and the regressors of the model are presented in table 7.

A second model was also tested, by using the revenue-to-GDP ratio (RR_{it}) as dependent variable. For this estimation, we drop the first set of regressors, since they are no longer relevant. The general specification of the model is given, then, by the following expression:

$$RR_{it} = \alpha + \sum_{J=1}^J b_J X_{Jit} + \varepsilon_{ij} \quad (8)$$

A variety of econometric specifications and robustness checks are run. Table 8 shows the results of the econometric specification of model (7). The equations are estimated by using panel fixed effects. As both autocorrelation and heteroscedasticity are detected in panel data analysis, a generalised least squares model is also run, allowing for heteroskedastic errors and across-group first order serial correlation. Moreover, in the same model we control for cross-country correlation using time dummies, which capture cross-sectional dependency caused by common time specific components.

4.3. ECONOMETRIC RESULTS: THE MAIN DETERMINANTS

Overall the models seem to well explain revenue error developments over time and across countries. The fitted value derived from model (3) yields the best results, proving to be broadly close to the actual series, particularly in the old Member States (see Figure D1 from Annex D). The empirical results are generally robust to the variety of regression specifications and robustness checks (see Table 8). It should be noted that interpretation of the results differs according to the type of the explanatory variables considered. A positive coefficient of an explanatory variable taking either positive or negative value (such as forecasting errors affecting real GDP and GDP deflator) will be interpreted as reducing revenue predictability, by amplifying positive and negative errors. By contrast, a positive coefficient of an explanatory variable taking only positive value (e.g. the degree of openness of the economy) will be interpreted as reducing the risk of over-forecasting (or conversely increasing the risk of under-forecasting).

As expected, the forecast errors for real GDP and the GDP deflator are found to be positively correlated to the prediction error for nominal revenue. Moreover, their impact appears highly significant and strong in magnitude in all equations. This is particularly the case for real GDP, as an increase of 1% in its forecast error is passed-through almost completely into the nominal revenue error. The effect of the error in GDP deflator is fairly weak in size, although highly significant. This lower coefficient may be accounted for by the positive correlation between the two errors, which is highly significant using Pearson's correlation test.

One of the strongest impacts (both in magnitude and significance) on the risk of overestimating government receipts seems to be exerted by the VAT compliance gap. Albeit reducing the number of observations, the variable produces robust estimates, confirming our expectations that wide-spread non-compliance to tax rules (often related to the existence of underground economy) decreases the risk of over-predicting nominal revenues.

Our empirical approach suggests that private consumption is negatively related to the over-estimation of government revenue. This may be due to the fact that forecasters use this information to better predict the revenue increase. It is common knowledge in the forecasting community that a strong growth in private consumption would lead to further VAT revenue. Indeed, revenue is not only affected by the level of GDP growth, but also by its composition. Nonetheless, although strongly significant in all equations, the effect of the annual growth rate of private consumption expenditures appears limited in magnitude.

The effect of the discretionary tax policies is found to be highly significant and robust. However, the negative sign of the estimator suggests that new tax measures are more efficiently quantified (by reducing the risk of over-estimation) than the spontaneous (endogenous) movements in revenue. In other words, discretionary changes in tax policy (i.e. new tax measures) seem to be accurately taken into account by the forecasters, leading to less upbeat forecast compared to a no-policy change scenario. Once we break down the variable into its components, we notice that the changes in corporate income tax and standard VAT rate are statistically significant and have both a negative sign as the overall indicator. Personal income tax, on the other hand, seems to have a poorer and less clear influence on the uncertainty of revenue. A possible explanation might be that the progressivity of the tax scale (also combined with numerous tax expenditures) makes the budgetary impact of the personal income tax measures more difficult to predict.

The house price index (not available for the entire time series) seems to positively influence the error. This may be due to the fact that the extra revenue collected from a booming housing market (also called tax windfall) generally takes the form of higher VAT on new built housing and on additional taxes from property

transactions. These developments in the housing market are particularly difficult to interpret and predict, since they could be affected by fundamentals, but also by a speculative behaviour¹⁹.

The degree of openness of the economy is also found to increase the propensity to over-estimate nominal revenue, implying that the more dynamic the role of trade in the growth of an economy, the more exposed the country is to negative external shocks, which are not easy to anticipate and forecast. Those may affect GDP error (already capturing the equation), but may also have an indirect effect on VAT revenue and excise duties collected on imported goods. The coefficient estimate is, however, unstable and occasionally insignificant across various estimations. Taking into account the import component (either as share of GDP or part of the trade-to-GDP indicator) does not improve the results of the model, as the new coefficients (not shown in the table) are generally not significantly different from zero and differ in sign. This confirms the lack of robustness of the effect of economic openness.

By contrast, the adjusted wage share does not show a clear influence on the revenue error. Its coefficient is highly unstable across specifications (ranging from 0.003 to 0.23) and its sign is opposite to what would be expected, given the supposedly lower volatility of the wage bill compared to GDP.

When considering the importance of the business cycle on the revenue error, our results indicate an insignificant and negligible effect, regardless of the model²⁰. Similar outcomes have been obtained for the size of the government, the exports growth rate and the share price index.

Table 8: Determinants of nominal revenue forecast error.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	GLS	Fixed Effects
Forecast error for real GDP	0.873*** (0.137)	0.955*** (0.128)	0.985*** (0.126)	1.064*** (0.146)	0.809*** (0.116)	0.871*** (0.217)
Forecast error for GDP deflator	0.656*** (0.160)	0.692*** (0.158)	0.638*** (0.156)	0.585*** (0.169)	0.619*** (0.119)	0.535** (0.245)
Size of government	0.0878 (0.0740)					
Business cycle	0.0785 (0.0865)					
Exports (growth rate)	-0.0324 (0.0240)					
Tax compliance	1.330*** (0.470)	1.193*** (0.441)	1.126*** (0.432)			
Private consumption (growth rate)	-0.0859* (0.0481)	-0.107*** (0.0366)	-0.130*** (0.0372)	-0.188*** (0.0384)	-0.112*** (0.0320)	-0.255*** (0.0629)
Openness of the economy	0.0756** (0.0368)	0.0594* (0.0342)	0.0572* (0.0335)	0.0377 (0.0318)	0.0230 (0.0294)	0.0562 (0.0530)
Discretionary tax measures	-0.131*** (0.0468)	-0.132*** (0.0466)				
Personal income tax (growth rate)			0.0205 (0.0251)	0.0135 (0.0279)	0.0142 (0.0190)	0.0219 (0.0409)
Corporate income tax (growth rate)			-0.0865*** (0.0288)	-0.0915*** (0.0319)	-0.0526*** (0.0202)	-0.0672 (0.0537)
Standard VAT (growth rate)			-0.157*** (0.0492)	-0.111** (0.0553)	-0.0679* (0.0374)	-0.0968 (0.0723)
House price index						0.0578* (0.0301)
Constant	-10.11** (3.926)	-5.101*** (1.961)	-4.654** (1.925)	-1.688 (1.876)	-1.354 (1.705)	-8.678* (5.096)
Observations	256	256	256	324	324	199
Number of countries	26	26	26	28	28	27

¹⁹ A lower index could be associated with less movement in housing prices or, alternatively, a strong correction of the market whose consequences on the revenue are easier to predict (such as revenue shortfall).

²⁰ Multiple estimations have been tested and they all convert to the same conclusion.

R-squared	0.451	0.443	0.472	0.337		0.345
Country fixed effects	YES	YES	YES	YES	YES	YES
Time fixed effects	NO	NO	NO	NO	YES	NO

Sources: Eurostat, OECD, Ameco database, CASE/CPB report (2012), EC taxation trends report (2014).

Note: Standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

Having a look at the GLS specification including time fixed effects, we find several significant time dummies²¹, indicating that the accuracy of the forecasts varies systematically across EU countries over time. The negative coefficients for 2005 and 2006 reflect the underestimations of the revenues in the pre-crisis years, while 2008 and 2012 depict the over forecast of government receipts in the first year of the global recession and immediately in the aftermath of the crisis. It must be pointed out that adding the time dummies does not substantially change the regression coefficients.

The second model, as derived from equation (8), also confirms the findings above about factors increasing and reducing the risk of over-forecasting revenue. As shown in Table 9, tax compliance, the degree of openness of the economy and the increase in house prices seems to significantly increase positive revenue forecast errors (over-forecasting), while the size of discretionary tax measures and the growth of “tax rich” components of GDP is associated with negative revenue forecast errors (under-forecasting). Results derived from model (8) are presented in Table D1 in Annex D. revenue-to-GDP model.

Table 9: Determinants of revenue-to-GDP forecast error.

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	GLS	Fixed Effects
Size of government	0.0736 (0.0700)					
Business cycle	0.0758 (0.0818)					
Exports (growth rate)	-0.0111 (0.0210)					
Tax compliance	1.122** (0.441)	1.036** (0.414)	0.977** (0.406)			
Private consumption (growth rate)	-0.0795* (0.0458)	-0.0832** (0.0343)	-0.104*** (0.0349)	-0.151*** (0.0350)	-0.0863*** (0.0305)	-0.182*** (0.0531)
Openness of the economy	0.0832** (0.0346)	0.0760** (0.0311)	0.0759** (0.0305)	0.0453 (0.0296)	0.0385 (0.0275)	0.0630 (0.0505)
Discretionary tax measures	-0.123*** (0.0443)	-0.123*** (0.0440)				
Personal income tax (growth rate)			0.0170 (0.0238)	0.0135 (0.0265)	0.00995 (0.0184)	0.0170 (0.0392)
Corporate income tax (growth rate)			-0.0772*** (0.0272)	-0.0829*** (0.0303)	-0.0504*** (0.0192)	-0.0683 (0.0515)
Standard VAT (growth rate)			-0.146*** (0.0465)	-0.0952* (0.0523)	-0.0556 (0.0366)	-0.0806 (0.0686)
House price index						0.0380 (0.0260)
Constant	-9.690*** (3.717)	-5.834*** (1.802)	-5.527*** (1.772)	-2.230 (1.737)	-2.327 (1.568)	-7.315 (4.825)
Observations	256	256	256	324	324	199
Number of countries	26	26	26	28	28	27

Sources: Eurostat, OECD, Ameco database, CASE/CPB report (2012), EC taxation trends report (2014).

Note: Standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

²¹ Only coefficients for the statistically significant time dummies are presented.

4.4. ROBUSTNESS ANALYSIS: DO ERROR DETERMINANTS PLAY SYMMETRICALLY?

An open question remains whether some of the factors behind the errors affect not only the risk of over-estimation but also the predictability at large regardless of the sign of the error. A simple way to test this would be to take the absolute value of the error as dependant variable. At the same time, such a formulation is extreme, since it assumes that the explanatory variable affect negative and positive errors in an identical fashion. A more pragmatic, i.e. assumption-free, approach consists in splitting the sample between negative and positive errors. This approach faces some drawback tough, since the sample size is halved, which alters the inference properties and the statistical power of the analysis. This justifies the initial econometric specification, but distinguishing negative from positive errors still represents a useful robustness exercise, especially because of the negative value of the errors on average for the euro area and many Member States. We replicate the results of Table 8 with the two alternative specifications. These are shown for specifications (1) and (3) in Table 10 below.

Table 10: Determinants of revenue-to-GDP forecast error, robustness check with modified error samples.

	Original value of errors	Absolute value of errors	Positive value of errors	Negative value of errors	Original value of errors	Absolute value of errors	Positive value of errors	Negative value of errors
	(1)	(1')	(1'')	(1''')	(3)	(3')	(3'')	(3''')
VARIABLES	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects	Fixed Effects
Forecast error for real GDP	0.873***	-0.0737	0.525***	-0.718***	0.985***	-0.0346	0.623***	-0.664***
	-0.137	-0.109	-0.155	-0.165	-0.126	-0.103	-0.149	-0.148
Forecast error for GDP deflator	0.656***	0.0434	0.386**	-0.452**	0.638***	0.055	0.392***	-0.517***
	-0.16	-0.127	-0.15	-0.175	-0.156	-0.127	-0.147	-0.171
Size of government	0.0878	0.113*	0.0349	0.13				
	-0.074	-0.0588	-0.0621	-0.1				
Business cycle	0.0785	0.136**	0.0886	0.171*				
	-0.0865	-0.0688	-0.0951	-0.0905				
Exports (growth rate)	-0.0324	-0.00413	-0.0432	-0.013				
	-0.024	-0.0191	-0.0271	-0.0235				
Tax compliance	1.330***	-0.355	-0.154	-1.869***	1.126***	-0.54	-0.281	-2.087***
	-0.47	-0.374	-0.549	-0.448	-0.432	-0.354	-0.518	-0.426
Private consumption (growth rate)	-0.0859*	0.00497	-0.0275	-0.067	-0.130***	0.0141	-0.061	-0.00999
	-0.0481	-0.0383	-0.0501	-0.052	-0.0372	-0.0305	-0.0376	-0.0423
Openness of the economy	0.0756**	-0.0793***	-0.027	-0.0264	0.0572*	-0.0765***	-0.0554	-0.0364
	-0.0368	-0.0293	-0.0447	-0.0341	-0.0335	-0.0275	-0.037	-0.0327
Discretionary tax measures	-0.131***	0.105***	-0.0117	0.161***				
	-0.0468	-0.0373	-0.0425	-0.0475				
Personal income tax (growth rate)					0.0205	0.0252	0.0226	0.0289
					-0.0251	-0.0205	-0.023	-0.0274
Corporate income tax (growth rate)					-0.0865***	0.0514**	-0.0151	0.0520*
					-0.0288	-0.0236	-0.0334	-0.0268
Standard VAT (growth rate)					-0.157***	0.0137	-0.0905	0.117**
					-0.0492	-0.0403	-0.0681	-0.0449
Constant	-10.11**	2.315	2.443	0.899	-4.654**	7.538***	5.718**	7.318***
	-3.926	-3.123	-3.538	-5.234	-1.925	-1.577	-2.212	-1.83
Observations								
Number of countries	256	256	105	151	256	256	105	151
R-squared	0.451	0.117	0.466	0.386	0.472	0.098	0.457	0.38
Country fixed effects	26	26	26	26	26	26	26	26
Time FE	NO	NO	NO	NO	NO	NO	NO	NO

Sources: Eurostat, OECD, Ameco database, CASE/CPB report (2012), EC taxation trends report (2014).

Note: Standard errors in parentheses: * significant at 10%; ** significant at 5%; *** significant at 1%.

The symmetric specification seems to reproduce the observed data less satisfactorily. Many statistically significant explanatory variables in the original specifications turn inefficient. The economic interpretation of the results derived from the new specification is not obvious, such as the absence of significance of the real GDP errors.

The importance of discretionary tax policy and the business cycle limit the extent of revenue under-estimation. In the presence of negative errors, an average (absolute) variation of 1% of the main tax rates reduces negative forecast errors of revenue growth by almost 0.2 percentage points. This suggests that new tax measures are less prone to the underestimation of their yields than the existing revenue. New tax measures are indeed documented in detail by governments in the budgetary law and may be easier to forecast than spontaneous developments in existing revenue. Looking further, it is mainly the new VAT measures, and to a lower extent the change in corporate income taxation, which limits revenue underestimation. The business cycle also has an impact on negative errors, likely through the endogenous part of revenue developments: in case of booming activity (positive output gap), the risk of underestimation decreases, since government's benefits from cyclical tax windfall. It should also be noted that the positive impact of both discretionary tax policy and the business cycle turns insignificant in the case of positive revenue error (over-estimation of revenue by forecasters).

More surprisingly, low tax compliance reduces revenue under-estimation. An explanation might be that forecasters already factor in likely tax shortfall in their projection of revenue particularly for countries suffering from an unsatisfactory respect of tax laws.

5. CONCLUSIONS

The paper provides an assessment of the uncertainty surrounding revenue predictions, through an analysis of European Commission forecasts over the last 15 years. It computes the forecast errors affecting revenue for all 28 Member States, using the different vintages of the autumn and spring Commission forecasts. The analysis consists in both an in-depth investigation of forecasting performance indicators and a panel data exercise aimed at shedding light on the possible drivers of the revenue forecast errors. While this study innovates by running a thorough analysis of forecast errors *on the revenue side specifically*, many results broadly confirm intuitive expectations. At the same time, it sheds new light on several aspects, in particular, the behaviour of forecast during the crisis outbreak and the subsequent period.

A comparison with OECD forecasts, alongside a battery of accuracy tests, confirms that the European Commission revenue forecasts are overall performing relatively well and, therefore, can be used to study "representative" errors of revenue forecasting. The analysis carried out in the paper is therefore suitable to illustrate the difficulties inherent to any attempt to predict revenue in the short-to-medium terms and, more generally, the uncertainty surrounding revenue behaviour at large. Indeed, when comparing summary statistics (ME, MAE and RMSE) run both on Commission and OECD forecasts for euro area countries (over a decade 2003-2013), the forecast accuracy turns out to be very similar, especially for the euro area as a whole. A closer scrutiny of the sub-periods of the sample shows that Commission revenue forecasts tend to perform better than OECD revenue forecasts both in the period preceding and following the outbreak of crisis. At the same time, parametric tests of forecasting accuracy confirm the sound track record of the European Commission forecast exercises, when it comes to revenue. Commission revenue forecasts do not suffer from inertia (i.e. errors being carried over) and are not biased in one direction (i.e. no systematic optimistic or pessimistic forecasting behaviour). They are also efficient in the sense that they used all available information at the time of the forecast.

This said, forecast errors for total revenue are far from negligible. While the mean error (ME) is fairly small in the EU as a whole - and close to zero in the euro area - for the spring forecast ("current year forecast"), it reaches 0.5 percentage point (pp.) of revenue growth per year on average in the EU for the autumn forecasts ("year-ahead forecast"). At EU level, the mean absolute error (MAE) is significantly larger than the mean error (ME), broadly reflecting the fact that errors of different sign broadly offset each other over time. The MAE is 0.9 p.p. of revenue growth for the spring forecast and 2.2 for the autumn forecast in the EU. This corresponds to average error of around 0.4 p.p. and 1 p.p. of GDP for the spring and autumn forecasts respectively. This difficulty in forecasting revenue at a one year/two year horizon further illustrates the relevance of considering risks of revenue windfall or shortfall in the conduct of fiscal policy. This point was – to a large extent – taken into account in innovations in fiscal surveillance introduced in the last five years, such as the introduction of an expenditure benchmark to supplement the structural balance in the preventive arm and the effective action methodology in the corrective arm.

The aggregate forecast errors mask very diverging developments at country level. Errors can be much larger in a given Member State than the sole EU aggregate makes one think. The forecast error as measured by the ME is smaller for the EU and euro area aggregates than for most of the individual countries, since errors of different sign counterbalance each other across countries. The dispersion of the ME and MAE across EU countries, measured by the cross-country standard deviation, is very telling in this respect: over 1 p.p. of revenue growth for ME and almost 2 p.p. of revenue growth for MAE in the spring forecast. The dispersion is significantly higher for the autumn forecast. Moreover, the picture is somewhat different in the Member States which joined the EU in 1995 or before and those having acceded more recently, with the latter exhibiting a less satisfactory forecasting performance, in particular during the pre-crisis period.

Three periods can be distinguished regarding the pattern of revenue forecast errors. The pre-crisis years (2001-2007) was characterised by slightly negative errors in both EU and the euro area, averaging at -0.5 point of revenue growth per year. The MAE estimators stood at around 1 pp. of revenue growth for the EU and the euro area as a whole, for the spring forecast. The dispersion of average forecast error across countries (measured

by the standard deviation of MAE in EU countries in spring forecast) was, however, the strongest of the three time periods covered (4.1 p.p. of nominal revenue growth), due to the very high forecast error for New Member States before and in the wake of the accession. The crisis outbreak (2008-2010) exhibited the poorest forecasting performance, in particular for the autumn forecasts (5.2 pp. at EU level in absolute terms). Revenue growth outturns in 2008 and 2009 were substantially weaker than had been forecast. By contrast, the revenue growth in 2010 was underestimated in the forecast. The clear deterioration of the forecasting accuracy in the crisis outbreak was due to the strong economic volatility, illustrating the difficulty for forecasters to anticipate major economic turning points. Not only, the general macro-economic conditions were difficult to foresee but also the very large revenue windfall, partly related to large contractions in asset prices in several Member States. The dispersion of the average forecast error across countries remained high: 1.8p.p. of nominal revenue growth. The subsequent period (2011-2013) was characterised by a noticeable improvement in the forecast accuracy, outperforming even that seen in the pre-crisis years. In general, over these three periods, the forecast errors in autumn forecasts (year-ahead forecasts) followed the same pattern as the spring forecast (current year forecast), but the magnitude of error was much larger. During the post-crisis years, the precision of the forecasts visibly improved in most EU countries, for both the current and year-ahead forecasts. The dispersion of the average absolute forecast error across countries was the lowest of the three periods considered (slightly over 1 p.p. of nominal revenue growth), although not negligible.

The forecast errors on nominal revenue forecast seem driven equally by the errors on macroeconomic variables and the errors on revenue as a share of GDP. The underestimation of revenue-to-GDP ratio (with the exception of very few countries) tends to offset the over-estimation of real GDP, explaining a fairly low forecast error (ME) of nominal revenue in the EU as a whole. The revenue-to-GDP ratio accounted for around half of the absolute forecast errors (MAE) of nominal revenue, with the other half being largely explained by real GDP and, to a lower extent, by GDP inflation. For the year-ahead forecast, the errors are larger, broadly attributable to a stronger overestimation of real GDP.

The forecast errors are the largest for direct taxes (i.e. current taxes on income and wealth) compared to the other tax categories. The receipts from indirect taxes (taxes on production and imports) were over-forecasted between 2001 and 2013 for most Member States. Social security contributions display the highest forecasting accuracy. The autumn forecasts reveal the same trends, with stronger forecasting inaccuracies for the direct and indirect taxes in the fairly recently acceded countries.

Overall, a panel data analysis seems to explain revenue error satisfactorily over time and across countries. The empirical results are generally robust to the variety of regression specifications and robustness checks. Using a GLS specification with time fixed effects, we find that several time dummies are statistically significant, indicating that the accuracy of revenue forecasts varies systematically over time.

The panel data analysis sheds light on some determinants of the revenue forecast errors, such as the forecast error affecting real GDP and the GDP deflator. As expected, the forecast errors affecting real GDP and the GDP deflator are found to be positively correlated to the prediction error of nominal revenue.

It also shows some factors increasing the risk of over-estimating forecasted revenue, such as the lack of tax compliance, the degree of openness of the economy and past increases in house prices. One of the strongest factors (both in magnitude and significance) increasing the risk of over-forecasting government receipts seems to be exerted by a low level of tax compliance, as proxied by the VAT compliance gap. The house price index (not available for the entire time series) also seems to be correlated with positive forecast errors. The degree of openness of the economy is also found to be positively related to over-forecasting nominal revenue, implying that the more important the role of trade in the economic growth of a country, the more exposed this country is to (unexpected) negative external shocks.

The econometric analysis also points to some factors limiting the risk of over-estimation of forecasted revenue, namely the size of discretionary tax measures and the growth of "tax rich" components of GDP. Firstly, the negative effect of the size of discretionary tax policy on the forecasting errors is found to be highly significant and robust. This would suggest that the new tax measures decided by the government are more

efficiently quantified in the forecast than the spontaneous (endogenous) movements in revenue. In other words, discretionary changes in tax policy seem to be accurately taken into account in Commission forecasts, leading to smaller risk of revenue overestimation compared to a no-policy-change scenario. Digging deeper, the error-reducing impact of discretionary measures is particularly relevant for measures affecting corporate income tax and social security contributions. Secondly, the growth in private consumption – "tax richer" or "VAT-intensive" component of GDP – is negatively related to the overestimation of government revenue, although this effect remains fairly small. This would suggest that the composition of growth may be taken into account satisfactorily in revenue forecasting.

By contrast, some potential factors of revenue forecast errors are not found to be significant empirically. The adjusted wage share, the business cycle, size of the government, the exports growth rate and the share price index do not seem to have a clear influence on the revenue error.

Robustness analysis confirms that error determinants, identified above, do not play symmetrically, impacting differently negative and positive error. The symmetric specification, using the absolute value of the error as dependant variable, seems to reproduce the observed data much less satisfactorily. Splitting the sample by sign of the errors appears insightful, showing the relevance of the sign of the errors. In particular, the importance of discretionary tax policy and the business cycle limit the extent of revenue under-estimation (negative errors), while these factors do not turn significant in case of over-estimation (positive errors). Besides, low tax compliance reduces revenue under-estimation, since probably already factored in by forecaster as a risk of tax shortfall, while not influencing revenue over-estimation.

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ANNEX A: Further descriptive results

Additional tables and graphs on the descriptive analysis of Commission revenue forecast

Table A1: Forecast errors for nominal revenue (current year)

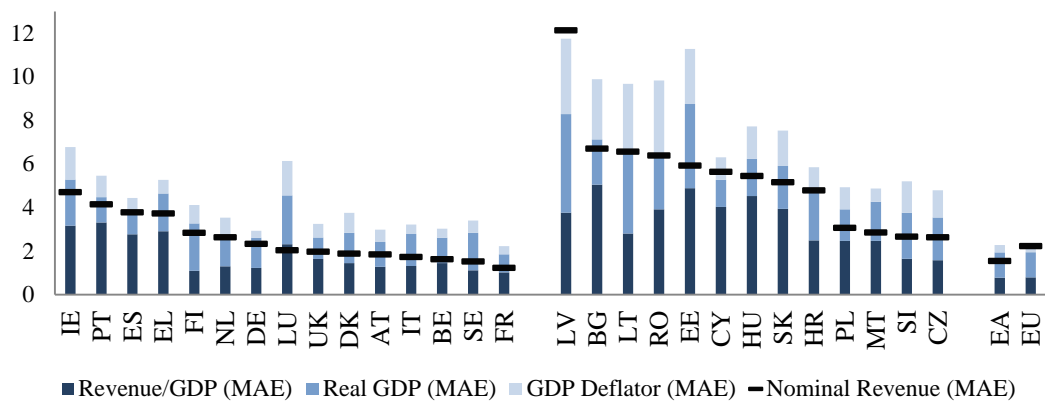
Country	Total			2001-2007			2008-2010			2011-2013		
	ME	MAE	RMSE	ME	MAE	RMSE	ME	MAE	RMSE	ME	MAE	RMSE
AT	-0.71	1.03	1.29	-0.59	1.14	1.37	-1.54	1.54	1.65	-0.15	0.27	0.34
BE	-0.89	1.31	1.62	-1.60	1.74	2.01	0.05	1.01	1.16	-0.17	0.59	0.74
BG	-0.51	5.52	6.79	-10.77	10.77	10.78	5.27	5.27	6.22	0.55	2.27	2.63
CY	-1.70	5.19	6.34	-8.12	8.12	8.89	1.44	4.45	5.48	1.59	2.99	3.42
CZ	0.62	2.14	2.72	-0.67	2.17	2.65	3.38	3.38	3.83	0.44	0.84	0.93
DE	-0.43	1.60	1.80	0.44	1.73	1.87	-1.52	1.52	1.77	-1.36	1.36	1.65
DK	-1.27	1.81	2.53	-0.88	1.53	2.16	-2.14	2.81	3.55	-1.28	1.45	2.06
EE	-1.86	3.93	4.95	-4.68	4.68	5.85	3.04	3.89	4.78	-2.05	2.72	3.17
EL	0.51	2.67	3.56	-0.53	2.03	2.73	4.47	4.47	5.27	-1.02	2.38	3.13
ES	0.75	2.96	4.08	-1.88	2.03	2.25	5.49	5.95	7.12	2.14	2.14	3.12
FI	-0.01	1.73	2.08	-0.79	1.64	1.94	1.14	2.78	2.94	0.68	0.89	1.18
FR	0.10	0.81	1.00	-0.25	0.70	0.84	0.78	1.36	1.50	0.23	0.54	0.64
HR	-1.93	8.51	14.38	-18.04	19.03	26.22	3.75	5.45	6.96	3.13	4.56	6.68
HU	-1.90	2.70	3.61	-4.91	4.91	5.34	0.00	0.55	0.60	0.22	1.90	2.27
IE	0.11	3.59	4.86	-2.22	3.91	4.46	5.42	5.42	7.37	0.25	1.00	1.23
IT	0.11	1.43	1.84	-0.95	1.49	1.94	1.01	1.01	1.31	1.70	1.70	2.07
LT	-0.67	4.45	5.08	-4.07	5.09	5.50	2.24	5.76	6.04	2.07	2.07	2.79
LU	-1.70	1.78	2.26	-1.61	1.65	2.11	-2.99	2.99	3.20	-0.62	0.84	1.27
LV	-4.55	6.81	8.53	-10.57	10.57	11.74	3.20	5.10	5.41	-2.27	2.27	2.82
MT	-0.69	1.87	2.29	-2.82	2.82	3.28	1.10	1.10	1.12	-0.34	1.69	1.95
NL	-0.06	1.42	1.83	-0.63	1.48	1.65	-0.51	1.02	1.21	1.70	1.70	2.57
PL	0.98	2.54	3.03	-0.49	2.40	2.79	2.40	2.40	2.65	3.00	3.00	3.84
PT	-0.62	2.62	3.22	-0.75	1.50	1.72	0.52	2.63	2.68	-1.44	5.20	5.56
RO	-0.65	5.60	6.80	-8.43	8.43	9.50	2.24	6.07	7.24	1.63	3.23	3.29
SE	-1.22	1.61	1.88	-1.74	1.74	1.92	-1.72	2.13	2.39	0.51	0.79	0.97
SI	-0.48	1.05	1.35	-0.72	1.37	1.86	-0.64	0.64	0.75	-0.09	1.15	1.21
SK	-1.59	4.97	6.71	-4.75	8.06	9.51	1.66	2.87	3.23	0.42	1.93	2.02
UK	-0.55	1.23	1.39	-0.15	1.23	1.40	-1.44	1.44	1.57	-0.59	1.02	1.17
EA	-0.03	0.92	1.17	-0.46	0.96	1.22	0.66	1.51	1.52	0.26	0.26	0.36
EU	-0.18	0.88	1.14	-0.50	1.02	1.27	0.22	1.30	1.36	0.16	0.16	0.17
Standard Deviation	1.10	1.93	2.86	4.21	4.10	5.17	2.35	1.79	2.19	1.39	1.15	1.42

Table A2: Forecast errors for nominal revenue (year-ahead)

Country	Total			2001-2007			2008-2010			2011-2012		
	ME	MAE	RMSE	ME	MAE	RMSE	ME	MAE	RMSE	ME	MAE	RMSE
AT	-0.67	1.84	2.32	-1.21	1.74	2.05	0.80	2.63	3.32	-1.01	1.01	1.01
BE	-0.36	1.63	2.24	-0.40	0.90	1.07	0.75	3.18	3.89	-1.84	1.84	1.85
BG	1.51	6.71	10.26	-13.04	13.04	13.04	7.94	7.94	12.31	-0.85	1.70	1.90
CY	0.67	5.64	7.48	-5.59	5.59	6.95	6.74	6.74	9.59	4.10	4.10	4.14
CZ	1.88	2.63	3.75	-0.27	1.16	1.70	5.79	5.79	6.26	1.38	1.59	2.11
DE	0.21	2.33	2.65	0.66	2.33	2.54	0.58	2.63	3.14	-1.88	1.88	2.24
DK	-0.16	1.88	2.44	-0.67	1.47	2.00	0.05	3.26	3.62	1.27	1.27	1.46
EE	-2.19	5.93	7.15	-6.06	6.12	7.43	6.80	6.80	8.14	-4.04	4.04	4.04
EL	1.13	3.73	5.30	-1.16	2.97	4.41	4.74	5.49	7.52	3.73	3.73	3.95
ES	1.05	3.78	5.33	-2.34	2.34	2.60	7.92	7.92	9.55	2.59	2.59	3.18
FI	0.05	2.84	3.63	-1.09	2.53	2.75	2.39	4.33	5.74	0.55	1.67	1.76
FR	0.29	1.23	2.09	-0.39	0.84	1.04	2.19	2.82	3.87	-0.20	0.20	0.28
HR	3.21	4.79	6.50	-4.74	4.74	4.74	7.70	7.70	8.76	0.44	0.44	0.48
HU	-1.97	5.45	8.92	-1.53	2.79	3.61	2.56	2.71	3.46	-9.64	14.87	17.71
IE	1.51	4.70	6.74	-1.16	3.65	4.43	8.92	10.02	11.66	-0.23	0.43	0.49
IT	0.41	1.73	2.21	-0.55	1.69	2.11	2.28	2.32	2.85	0.97	0.97	1.25
LT	-0.50	6.56	9.69	-5.77	5.77	6.96	6.86	10.48	15.03	1.63	2.67	3.13
LU	-1.00	2.03	2.67	-1.58	1.96	2.25	-0.18	3.37	4.09	-0.19	0.30	0.36
LV	-5.54	12.14	13.10	-11.90	11.90	12.72	6.22	15.78	16.25	-7.28	7.28	7.56
MT	-1.32	2.86	3.85	-3.72	4.22	5.11	1.84	1.91	2.65	-1.28	1.53	2.00
NL	0.53	2.63	3.39	-1.05	1.92	2.32	2.28	3.76	4.98	3.46	3.46	3.60
PL	0.72	3.06	4.04	-0.46	3.11	3.53	3.10	3.32	5.50	0.68	2.54	2.63
PT	0.01	4.15	4.94	-0.68	2.42	2.82	1.06	5.46	5.76	0.82	8.23	8.27
RO	1.41	6.39	9.28	-9.70	9.70	9.70	5.86	7.44	11.57	0.30	3.17	3.19
SE	-0.22	1.52	1.93	-0.94	1.05	1.37	0.78	3.12	3.16	0.78	0.78	0.93
SI	0.85	2.66	3.69	-1.14	2.36	2.80	2.59	3.35	5.17	2.23	2.23	2.36
SK	3.92	5.16	8.49	4.21	6.51	10.41	5.48	5.79	7.69	0.87	0.87	0.89
UK	0.12	1.97	3.13	-0.39	1.18	1.30	1.68	4.77	5.90	-0.42	0.55	0.69
EA	0.39	1.54	2.30	-0.40	1.07	1.40	2.44	3.41	4.06	0.09	0.41	0.42
EU	0.55	2.23	3.21	-0.32	1.45	1.59	3.29	5.18	5.92	-0.52	0.52	0.56
Standard Deviation	1.72	2.31	2.97	3.75	3.15	3.38	2.78	3.07	3.70	2.91	3.01	3.41

Figure A1: Decomposition of nominal revenue error

(a) in ME (year-ahead)



b) in MAE (year-ahead)

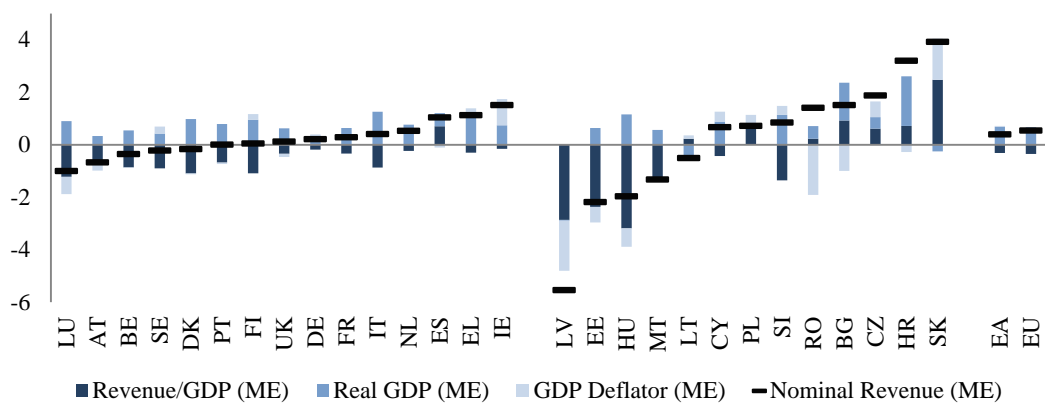


Figure A2: Forecast error for revenue-to-GDP (year-ahead)

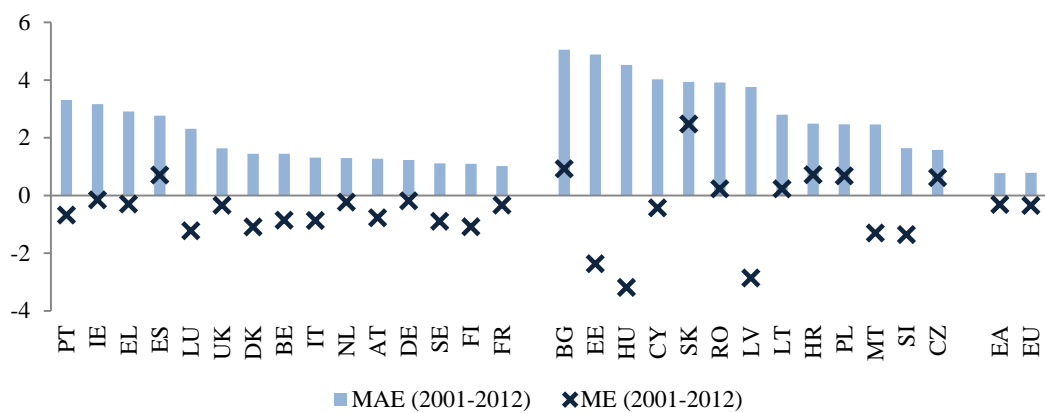


Figure A3: Revenue-to-GDP error by sub-period (year-ahead)

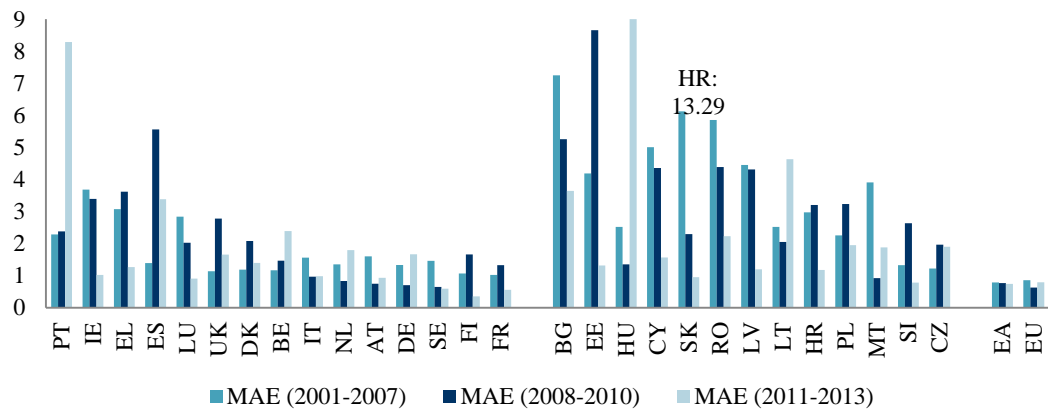


Figure A4: Forecast errors for indirect taxes, direct taxes and social contributions by sub-periods (year-ahead)

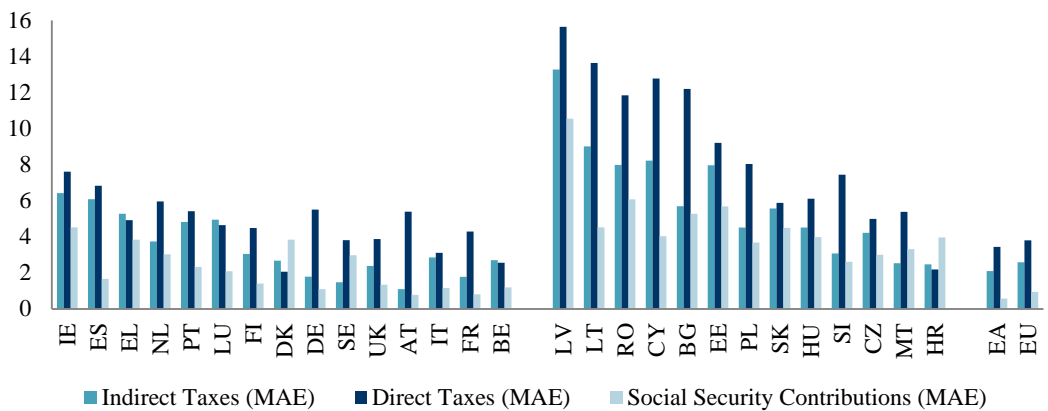
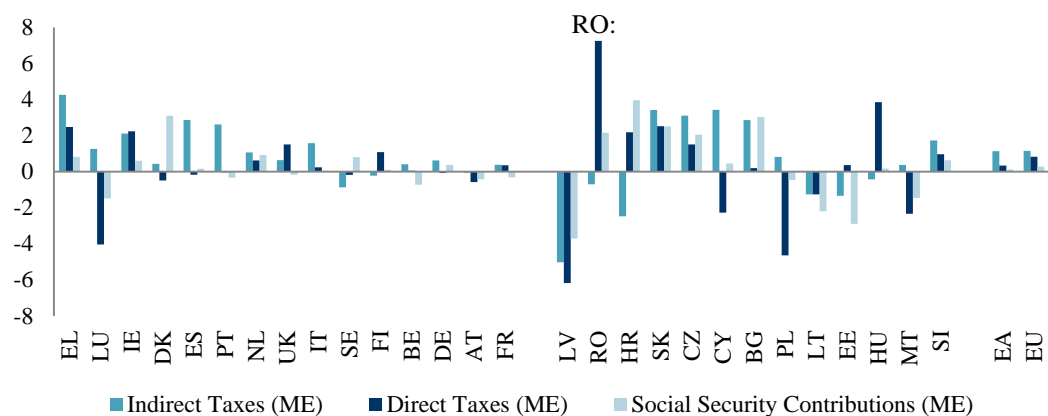


Figure A5: Forecast errors for indirect taxes, direct taxes and social contributions (year-ahead)



ANNEX B: Detailed results of accuracy tests

Table B1: Persistence in current-year forecast error

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EA	EU	
Nominal revenue																															
Signif p1=0	0.04	0.14	0.19	0.64	0.55	0.01	0.12	0.66	0.24	0.30	0.78	0.42	0.95	0.05	0.12	0.49	0.59	0.46	0.03	0.10	0.61	0.43	0.16	0.86	0.50	0.36	0.80	0.49	0.25	0.06	
Signif p2=0	0.11	0.34	0.28	0.81	0.82	0.02	0.05	0.48	0.43	0.56	0.17	0.57	0.97	0.12	0.29	0.62	0.38	0.75	0.09	0.26	0.86	0.57	0.21	0.46	0.73	0.40	0.40	0.21	0.22	0.12	
Signif p3=0	0.19	0.51	0.18	0.81	0.89	0.04	0.00	0.53	0.08	0.73	0.30	0.13	0.91	0.23	0.37	0.60	0.56	0.46	0.12	0.32	0.96	0.76	0.37	0.41	0.89	0.49	0.53	0.35	0.23	0.13	
Real revenue																															
Signif p1=0	0.04	0.34	0.20	0.78	0.78	0.02	0.27	0.79	0.34	0.41	0.58	0.22	0.89	0.02	0.30	0.62	0.89	0.50	0.03	0.13	0.75	0.76	0.24	0.71	0.46	0.27	0.84	0.59	0.18	0.10	
Signif p2=0	0.12	0.52	0.28	0.92	0.75	0.03	0.19	0.78	0.56	0.59	0.36	0.20	0.97	0.03	0.54	0.45	0.82	0.31	0.07	0.31	0.93	0.92	0.35	0.14	0.24	0.54	0.37	0.17	0.20	0.18	
Signif p3=0	0.15	0.67	0.15	0.87	0.80	0.08	0.00	0.90	0.20	0.78	0.49	0.02	0.94	0.07	0.71	0.61	0.84	0.15	0.12	0.33	0.94	0.69	0.55	0.26	0.29	0.74	0.49	0.29	0.21	0.11	
Revenue/GDP																															
Signif p1=0	0.09	0.35	0.21	0.43	0.39	0.13	0.33	0.35	0.43	0.42	0.45	0.95	0.76	0.01	0.30	0.41	0.75	0.63	0.05	0.33	0.93	0.68	0.26	0.83	0.57	0.68	0.87	0.59	0.20	0.26	
Signif p2=0	0.12	0.16	0.29	0.71	0.67	0.30	0.45	0.55	0.63	0.64	0.61	0.96	0.89	0.02	0.58	0.72	0.84	0.89	0.06	0.60	0.55	0.90	0.24	0.12	0.43	0.74	0.30	0.10	0.32	0.50	
Signif p3=0	0.07	0.25	0.18	0.87	0.83	0.49	0.07	0.61	0.23	0.78	0.75	0.62	0.93	0.04	0.73	0.86	0.86	0.27	0.12	0.67	0.59	0.58	0.40	0.24	0.30	0.59	0.50	0.20	0.13	0.15	
Real GDP																															
Signif p1=0	0.53	0.72	0.59	0.14	0.30	0.26	0.76	0.11	0.01	0.28	0.64	0.37	0.30	0.79	0.04	0.36	0.41	1.00	0.12	0.75	0.26	0.90	0.66	0.50	0.86	0.89	0.45	0.77	0.78	0.17	
Signif p2=0	0.74	0.86	0.85	0.20	0.51	0.48	0.21	0.07	0.03	0.30	0.57	0.67	0.42	0.07	0.10	0.09	0.69	0.14	0.16	0.34	0.40	0.63	0.72	0.46	0.54	0.99	0.67	0.35	0.94	0.39	
Signif p3=0	0.86	0.93	0.71	0.08	0.66	0.67	0.31	0.01	0.07	0.25	0.73	0.61	0.45	0.14	0.21	0.14	0.81	0.20	0.08	0.53	0.58	0.82	0.79	0.67	0.47	1.00	0.81	0.34	0.88	0.57	
Indirect taxes																															
Signif p1=0	0.49	0.27	0.23	0.94	0.72	0.64	0.10	0.16	0.99	0.71	0.37	0.82	0.16	0.51	0.23	0.64	0.60	0.86	0.87	0.04	0.40	0.85	0.65	0.64	0.22	0.84	0.21	0.80	0.77	0.23	
Signif p2=0	0.68	0.48	0.48	0.93	0.85	0.89	0.26	0.23	0.99	0.84	0.37	0.89	.	0.20	0.37	0.12	0.13	0.70	0.17	0.11	0.70	0.67	0.89	0.15	0.36	0.65	0.41	0.05	0.32	0.26	
Signif p3=0	0.78	0.62	0.29	0.97	0.83	0.97	0.39	0.37	0.83	0.94	0.47	0.18	.	0.09	0.14	0.24	0.20	0.87	0.19	0.22	0.85	0.76	0.50	0.28	0.37	0.82	0.48	0.11	0.32	0.43	
Direct taxes																															
Signif p1=0	0.34	0.79	0.62	0.50	0.50	0.01	0.12	0.07	0.88	0.20	0.90	0.89	0.16	0.94	0.19	0.49	0.98	0.65	0.29	0.21	0.15	0.01	0.51	0.79	0.12	0.55	0.05	0.50	0.05	0.76	
Signif p2=0	0.53	0.54	0.70	0.73	0.46	0.01	0.20	0.12	0.45	0.42	0.91	0.71	.	0.90	0.36	0.79	0.67	0.46	0.08	0.37	0.21	0.03	0.61	0.96	0.19	0.81	0.15	0.59	0.09	0.47	
Signif p3=0	0.21	0.63	0.61	0.88	0.35	0.04	0.03	0.12	0.16	0.50	0.94	0.31	.	0.92	0.56	0.75	0.79	0.36	0.04	0.52	0.25	0.02	0.80	0.85	0.31	0.94	0.21	0.58	0.02	0.61	
Social contributions																															
Signif p1=0	0.23	0.86	0.94	0.35	0.98	0.02	0.79	0.11	0.70	0.11	0.75	0.30	0.16	0.27	0.01	0.89	0.63	0.12	0.18	0.49	0.53	0.35	0.32	1.00	0.10	0.24	0.96	0.33	0.89	0.96	
Signif p2=0	0.48	0.93	0.52	0.29	0.13	0.01	0.59	0.27	0.03	0.15	0.17	0.57	.	0.30	0.01	0.99	0.88	0.08	0.20	0.30	0.61	0.45	0.60	0.34	0.25	0.48	0.11	0.61	0.97	0.98	
Signif p3=0	0.59	0.80	0.37	0.46	0.25	0.03	0.69	0.28	0.06	0.22	0.22	0.70	.	0.49	0.01	0.23	0.79	0.05	0.14	0.21	0.65	0.45	0.69	0.54	0.29	0.39	0.18	0.43	0.65	1.00	

Note: The test for serial correlation is based on the Ljung-Box Q statistic, which is asymptotically distributed as chi-square. Significance levels of autocorrelation coefficients up to three lags are reported.

Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

Table B2: Persistence in year-ahead forecast error

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EA	EU
Nominal revenue																														
Signif p1=0	0.88	0.43	0.96	0.30	0.63	0.24	0.80	0.70	0.81	0.09	0.38	0.88	0.54	0.42	0.10	0.92	0.98	0.27	0.37	0.09	0.81	0.49	0.29	0.66	0.32	0.95	0.27	0.18	0.62	0.80
Signif p2=0	0.33	0.64	0.25	0.49	0.26	0.38	0.73	0.65	0.97	0.24	0.40	0.92	0.08	0.42	0.22	0.29	0.58	0.54	0.42	0.20	0.50	0.49	0.06	0.13	0.27	0.65	0.54	0.41	0.34	0.53
Signif p3=0	0.32	0.63	0.39	0.66	0.44	0.33	0.70	0.45	0.50	0.41	0.60	0.68	0.08	0.59	0.06	0.43	0.78	0.69	0.55	0.21	0.55	0.50	0.09	0.21	0.35	0.83	0.69	0.49	0.22	0.26
Real revenue																														
Signif p1=0	0.93	0.38	0.97	0.35	0.49	0.16	0.51	0.73	0.81	0.17	0.24	0.82	0.62	0.43	0.19	0.78	0.68	0.22	0.34	0.06	0.87	0.87	0.37	0.59	0.56	0.59	0.21	0.35	0.59	0.70
Signif p2=0	0.30	0.65	0.41	0.52	0.09	0.33	0.35	0.78	0.97	0.38	0.41	0.84	0.13	0.46	0.33	0.13	0.75	0.46	0.42	0.16	0.51	0.82	0.12	0.09	0.29	0.82	0.46	0.60	0.27	0.50
Signif p3=0	0.14	0.65	0.46	0.72	0.15	0.32	0.33	0.84	0.49	0.56	0.56	0.52	0.12	0.63	0.13	0.24	0.88	0.20	0.57	0.16	0.57	0.87	0.21	0.13	0.43	0.82	0.67	0.32	0.14	0.17
Revenue/GDP																														
Signif p1=0	0.96	0.13	0.95	0.23	0.14	0.10	0.51	0.11	0.67	0.27	0.57	0.72	0.78	0.18	0.55	0.18	0.02	0.86	0.88	0.17	0.64	0.98	0.37	0.25	0.29	0.51	0.23	0.28	0.43	0.67
Signif p2=0	0.45	0.27	0.59	0.41	0.25	0.20	0.25	0.90	0.54	0.64	0.87	0.52	0.40	0.78	0.20	0.04	0.83	0.63	0.32	0.38	0.98	0.21	0.18	0.47	0.80	0.42	0.55	0.46	0.84	
Signif p3=0	0.33	0.44	0.46	0.51	0.19	0.35	0.02	0.34	0.27	0.73	0.82	0.67	0.16	0.58	0.36	0.08	0.05	0.93	0.79	0.44	0.57	1.00	0.37	0.16	0.45	0.83	0.62	0.42	0.08	0.14
Real GDP																														
Signif p1=0	0.66	0.35	0.30	0.34	0.64	0.64	0.60	0.08	0.00	0.51	0.63	0.53	0.53	0.49	0.56	0.66	0.35	0.15	0.47	0.66	0.81	0.33	0.80	0.73	0.86	0.91	0.51	0.67	0.66	
Signif p2=0	0.64	0.38	0.59	0.42	0.69	0.48	0.81	0.12	0.00	0.39	0.49	0.63	0.51	0.82	0.49	0.14	0.60	0.36	0.24	0.41	0.86	0.36	0.42	0.96	0.50	0.76	0.70	0.70	0.33	0.39
Signif p3=0	0.43	0.58	0.73	0.36	0.81	0.54	0.74	0.03	0.01	0.57	0.69	0.53	0.59	0.94	0.61	0.24	0.80	0.43	0.21	0.20	0.92	0.55	0.61	0.99	0.48	0.89	0.74	0.85	0.48	0.54
Indirect taxes																														
Signif p1=0	0.03	0.19	0.34	0.71	0.09	0.65	0.19	0.85	0.88	0.12	0.84	0.44	0.92	0.15	0.87	0.91	0.44	0.36	0.70	0.51	0.73	0.72	0.48	0.78	0.39	0.52	0.87	0.36	0.67	
Signif p2=0	0.08	0.24	0.55	0.73	0.21	0.80	0.42	0.87	0.83	0.23	0.74	0.74	0.49	0.36	0.06	0.36	0.31	0.28	0.85	0.80	0.59	0.56	0.31	0.19	0.69	0.48	0.16	0.47	0.63	
Signif p3=0	0.13	0.10	0.69	0.59	0.27	0.61	0.52	0.44	0.90	0.37	0.86	0.40	0.59	0.08	0.12	0.54	0.25	0.23	0.80	0.90	0.77	0.43	0.49	0.32	0.78	0.56	0.28	0.22	0.33	
Direct taxes																														
Signif p1=0	0.87	0.69	0.64	0.60	0.78	0.09	0.48	0.22	0.39	0.23	0.55	0.46	0.24	0.08	0.79	0.85	0.31	0.96	0.76	0.36	0.12	0.84	0.76	0.35	0.23	0.73	0.57	0.57	0.65	
Signif p2=0	0.54	0.83	0.33	0.82	0.65	0.23	0.68	0.09	0.67	0.48	0.39	0.69	0.45	0.12	0.77	0.93	0.46	0.34	0.66	0.09	0.29	0.50	0.18	0.31	0.48	0.93	0.76	0.25	0.37	
Signif p3=0	0.31	0.54	0.42	0.94	0.47	0.25	0.43	0.06	0.85	0.49	0.59	0.50	0.26	0.03	0.68	0.66	0.64	0.48	0.39	0.09	0.39	0.69	0.30	0.39	0.66	0.62	0.89	0.09	0.16	
Social contributions																														
Signif p1=0	0.68	0.65	0.89	0.21	0.60	0.58	0.80	0.30	0.40	0.14	0.77	0.84	0.91	0.04	0.91	0.20	0.20	0.30	0.19	0.94	0.90	0.77	0.57	0.01	0.38	0.92	0.18	0.46	0.53	
Signif p2=0	0.82	0.86	0.06	0.40	0.26	0.67	0.96	0.31	0.61	0.23	0.66	0.15	0.09	0.03	0.83	0.37	0.44	0.05	0.21	0.92	0.98	0.89	0.18	0.01	0.56	0.46	0.30	0.62	0.68	
Signif p3=0	0.27	0.95	0.13	0.30	0.26	0.39	0.96	0.37	0.27	0.18	0.69	0.21	0.19	0.06	0.85	0.42	0.64	0.02	0.11	0.82	1.00	0.28	0.29	0.02	0.66	0.46	0.49	0.64	0.55	

Note: The test for serial correlation is based on the Ljung-Box Q statistic, which is asymptotically distributed as chi-square. Significance levels of autocorrelation coefficients up to three lags are reported.

Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

Table B3: Bias in current-year forecast error

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EA	EU
Nominal revenue																														
α	-0.71	-0.89	-0.51	-1.70	0.62	-0.43	-1.27	-1.86	0.51	0.75	-0.01	0.10	-1.93	-1.90	0.11	0.11	-0.67	-1.70	-4.55	-0.69	-0.06	0.98	-0.62	-0.65	-1.22	-0.48	-1.59	-0.55	0.20	0.27
p-value $\alpha=0$	0.04	0.04	0.85	0.46	0.45	0.41	0.07	0.23	0.62	0.53	0.99	0.74	0.73	0.10	0.94	0.84	0.68	0.00	0.07	0.40	0.91	0.26	0.51	0.81	0.01	0.31	0.46	0.17	0.63	0.52
Adjusted sample size	13.00	13.00	8.00	9.00	12.00	13.00	13.00	11.00	13.00	13.00	13.00	13.00	8.00	10.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	8.00	13.00	9.00	11.00	13.00	13.00	13.00
Real revenue																														
α	-0.45	-0.92	0.59	-2.33	0.34	-0.41	-1.35	-0.83	0.50	0.91	0.29	0.11	-1.46	-2.35	-0.45	0.06	0.32	-1.60	-1.93	-0.59	-0.22	0.54	-0.59	0.00	-1.21	-0.53	-2.82	-0.42	0.18	0.21
p-value $\alpha=0$	0.20	0.02	0.79	0.22	0.66	0.44	0.03	0.50	0.63	0.43	0.57	0.70	0.79	0.06	0.72	0.90	0.80	0.05	0.30	0.51	0.66	0.47	0.51	1.00	0.03	0.18	0.19	0.38	0.65	0.60
Adjusted sample size	13.00	13.00	8.00	9.00	12.00	13.00	13.00	11.00	13.00	13.00	13.00	13.00	8.00	10.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	8.00	13.00	9.00	11.00	13.00	13.00	13.00
Revenue/GDP																														
α	-0.44	-1.01	0.27	-2.15	0.31	-0.33	-2.01	-0.97	0.05	0.99	-0.27	-0.09	-2.03	-2.50	-0.49	-0.49	0.75	-1.83	-1.07	-0.17	-0.58	0.75	-0.74	-0.10	-1.18	-1.06	-2.22	-0.67	-0.23	-0.35
p-value $\alpha=0$	0.19	0.01	0.89	0.18	0.58	0.40	0.00	0.41	0.95	0.34	0.33	0.75	0.69	0.04	0.65	0.26	0.41	0.07	0.39	0.84	0.15	0.39	0.40	0.96	0.02	0.13	0.26	0.22	0.32	0.12
Adjusted sample size	13.00	13.00	8.00	9.00	12.00	13.00	13.00	11.00	13.00	13.00	13.00	13.00	8.00	10.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	8.00	13.00	9.00	11.00	13.00	13.00	13.00
Real GDP																														
α	-0.01	0.10	0.72	-0.03	0.02	-0.08	0.68	-0.06	0.41	-0.05	0.57	0.21	0.68	0.33	0.09	0.57	-0.70	0.23	-0.78	-0.01	0.37	-0.22	0.15	-0.40	-0.03	0.42	-0.53	0.25	0.41	0.59
p-value $\alpha=0$	0.96	0.66	0.23	0.94	0.96	0.78	0.02	0.94	0.25	0.71	0.26	0.22	0.13	0.21	0.87	0.01	0.27	0.67	0.44	0.97	0.14	0.61	0.58	0.48	0.94	0.38	0.12	0.20	0.15	0.13
Adjusted sample size	13.00	13.00	13.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	9.00	13.00	13.00	13.00	13.00	13.00	13.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00
Indirect taxes																														
α	-0.07	0.41	2.15	0.41	0.46	0.46	0.87	-1.15	2.98	0.93	-0.20	-0.42	6.65	0.05	0.89	1.51	-1.17	-0.51	-4.17	2.89	1.04	0.93	0.15	-2.23	-1.76	0.16	3.24	-0.16	0.89	0.89
p-value $\alpha=0$	0.88	0.64	0.33	0.90	0.75	0.30	0.26	0.66	0.02	0.65	0.76	0.37	0.33	0.93	0.63	0.13	0.54	0.70	0.19	0.11	0.29	0.51	0.92	0.51	0.03	0.88	0.07	0.83	0.20	0.19
Adjusted sample size	13.00	13.00	7.00	9.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	2.00	11.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	7.00	13.00	9.00	11.00	13.00	13.00	13.00
Direct taxes																														
α	-2.63	-0.29	-1.14	-5.30	1.05	-1.58	-2.67	-5.73	1.48	-0.25	-0.02	0.64	2.22	1.18	1.01	-0.14	-2.44	-3.33	-6.45	-5.08	-0.64	-1.51	-0.18	5.65	-2.00	0.44	0.47	1.07	-0.17	0.01
p-value $\alpha=0$	0.04	0.65	0.85	0.31	0.46	0.21	0.06	0.01	0.35	0.91	0.98	0.63	0.83	0.52	0.66	0.89	0.62	0.03	0.05	0.04	0.70	0.40	0.93	0.04	0.12	0.54	0.79	0.28	0.84	0.99
Adjusted sample size	13.00	13.00	7.00	9.00	12.00	13.00	13.00	13.00	13.00	13.00	13.00	13.00	2.00	10.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	7.00	13.00	9.00	11.00	13.00	13.00	13.00
Social contributions																														
α	-0.55	-0.42	0.97	-6.82	0.48	-0.26	-0.68	-2.60	-0.48	-0.10	-0.51	-0.26	-3.33	-0.82	-1.84	0.11	-2.36	-1.30	-4.68	-0.98	0.29	-0.16	-1.09	1.59	1.74	-1.43	-0.12	-0.72	0.03	0.24
p-value $\alpha=0$	0.01	0.04	0.43	0.00	0.63	0.32	0.43	0.14	0.69	0.75	0.25	0.31	0.22	0.55	0.08	0.74	0.16	0.09	0.08	0.45	0.72	0.85	0.39	0.49	0.20	0.02	0.94	0.18	0.90	0.55
Adjusted sample size	13.00	13.00	7.00	9.00	12.00	13.00	13.00	11.00	13.00	13.00	13.00	13.00	2.00	11.00	13.00	13.00	11.00	13.00	11.00	9.00	13.00	13.00	13.00	7.00	13.00	9.00	11.00	13.00	13.00	13.00

Note: α : coefficient in regression (1). P-value $\alpha=0$ denote p-values for the $\alpha=0$ t-test. Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

Table B4: Bias in year-ahead forecast error

	AT	BE	BG	CY	CZ	DE	DK	EE	EL	ES	FI	FR	HR	HU	IE	IT	LT	LU	LV	MT	NL	PL	PT	RO	SE	SI	SK	UK	EA	EU
Nominal revenue (autumn)																														
α	-0.67	-0.36	1.51	0.67	1.88	0.21	-0.16	-2.19	1.13	1.05	0.05	0.29	3.21	-1.97	1.51	0.41	-0.50	-1.00	-5.54	-1.32	0.53	0.72	0.01	1.41	-0.22	0.85	3.92	0.12	0.39	0.55
p-value $\alpha=0$	0.34	0.60	0.75	0.81	0.12	0.79	0.83	0.33	0.48	0.52	0.96	0.65	0.26	0.54	0.46	0.54	0.88	0.21	0.20	0.33	0.61	0.58	1.00	0.75	0.71	0.52	0.15	0.90	0.58	0.58
Adjusted sample size	12.00	12.00	6.00	9.00	10.00	12.00	12.00	11.00	12.00	12.00	12.00	12.00	6.00	9.00	12.00	12.00	10.00	12.00	10.00	9.00	12.00	11.00	12.00	6.00	12.00	9.00	10.00	12.00	12.00	12.00
Real revenue (autumn)																														
α	-0.45	-0.33	2.58	0.23	1.00	0.16	-0.12	-1.66	0.97	1.17	-0.17	0.29	3.36	-2.07	0.54	0.37	0.09	-0.32	-2.64	-1.20	0.51	0.43	0.09	2.62	-0.49	-0.14	2.40	0.25	0.36	0.53
p-value $\alpha=0$	0.42	0.58	0.49	0.92	0.37	0.84	0.83	0.38	0.51	0.42	0.86	0.59	0.18	0.49	0.75	0.60	0.97	0.71	0.44	0.31	0.53	0.73	0.95	0.39	0.47	0.91	0.29	0.77	0.57	0.56
Adjusted sample size	12.00	6.00	9.00	10.00	12.00	12.00	12.00	11.00	12.00	12.00	12.00	12.00	6.00	9.00	12.00	12.00	10.00	12.00	10.00	9.00	12.00	11.00	12.00	6.00	12.00	9.00	10.00	12.00	12.00	12.00
Revenue/GDP (autumn)																														
α	-0.78	-0.86	0.92	-0.43	0.62	-0.19	-1.09	-2.37	-0.30	0.70	-1.09	-0.34	0.71	-3.19	-0.16	-0.87	0.23	-1.23	-2.86	-1.30	-0.23	0.68	-0.68	0.23	-0.90	-1.36	2.48	-0.34	-0.32	-0.35
p-value $\alpha=0$	0.13	0.08	0.72	0.82	0.33	0.68	0.03	0.27	0.80	0.54	0.00	0.35	0.58	0.28	0.89	0.08	0.84	0.15	0.07	0.30	0.65	0.52	0.59	0.92	0.05	0.02	0.23	0.60	0.25	0.20
Adjusted sample size	12.00	12.00	6.00	9.00	10.00	12.00	12.00	11.00	12.00	12.00	12.00	12.00	6.00	9.00	12.00	12.00	10.00	12.00	10.00	9.00	12.00	11.00	12.00	6.00	12.00	9.00	10.00	12.00	12.00	12.00
Real GDP (autumn)																														
α	0.33	0.55	1.44	0.88	0.44	0.35	0.98	0.64	1.24	0.50	0.95	0.64	1.89	1.16	0.74	1.25	-0.57	0.90	-0.03	0.57	0.76	0.11	0.79	0.48	0.43	1.14	-0.25	0.63	0.68	0.67
p-value $\alpha=0$	0.51	0.19	0.18	0.10	0.60	0.54	0.08	0.70	0.07	0.24	0.33	0.04	0.13	0.11	0.42	0.02	0.73	0.28	0.99	0.41	0.15	0.84	0.05	0.68	0.55	0.28	0.80	0.13	0.14	0.15
Adjusted sample size	12.00	12.00	12.00	11.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	8.00	12.00	12.00	12.00	12.00	12.00	11.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00	12.00
Indirect taxes (autumn)																														
α	-0.06	0.41	2.86	3.43	3.11	0.63	0.44	-1.33	4.27	2.87	-0.22	0.38	.	-0.42	2.11	1.58	-1.26	1.26	-5.02	0.38	1.07	0.82	2.62	-0.69	-0.86	1.73	3.42	0.64	1.29	1.16
p-value $\alpha=0$	0.88	0.68	0.56	0.44	0.03	0.40	0.67	0.71	0.04	0.26	0.84	0.55	.	0.84	0.41	0.16	0.74	0.52	0.31	0.76	0.46	0.71	0.15	0.89	0.15	0.21	0.17	0.50	0.18	0.31
Adjusted sample size	12.00	12.00	6.00	8.00	9.00	12.00	12.00	9.00	12.00	12.00	12.00	12.00	.	9.00	12.00	12.00	9.00	12.00	9.00	8.00	12.00	9.00	12.00	6.00	12.00	8.00	9.00	12.00	11.00	12.00
Direct taxes (autumn)																														
α	-0.58	0.06	0.20	-2.26	1.52	-0.07	-0.48	0.37	2.48	-0.16	1.09	0.36	.	3.86	2.24	0.25	-1.26	-4.04	-6.18	-2.33	0.63	-4.64	-0.03	7.26	-0.17	0.97	2.52	1.51	-0.03	0.83
p-value $\alpha=0$	0.78	0.96	0.98	0.71	0.52	0.97	0.59	0.93	0.14	0.95	0.53	0.86	.	0.23	0.47	0.85	0.87	0.01	0.36	0.40	0.77	0.17	0.99	0.29	0.91	0.78	0.45	0.30	0.99	0.59
Adjusted sample size	12.00	12.00	6.00	8.00	9.00	12.00	12.00	9.00	12.00	12.00	12.00	12.00	.	8.00	12.00	12.00	9.00	12.00	9.00	8.00	12.00	9.00	12.00	6.00	12.00	8.00	9.00	12.00	11.00	12.00
Social contributions (autumn)																														
α	-0.42	-0.72	3.03	0.46	2.06	0.38	3.10	-2.89	0.83	0.17	0.10	-0.30	.	0.17	0.61	0.06	-2.19	-1.48	-3.71	-1.45	0.92	-0.47	-0.33	2.16	0.81	0.63	2.51	-0.17	0.16	0.28
p-value $\alpha=0$	0.13	0.06	0.31	0.81	0.23	0.34	0.03	0.28	0.58	0.80	0.88	0.33	.	0.93	0.72	0.89	0.22	0.03	0.40	0.32	0.43	0.78	0.73	0.52	0.57	0.61	0.21	0.76	0.63	0.59
Adjusted sample size	12.00	12.00	6.00	8.00	9.00	12.00	12.00	9.00	12.00	12.00	12.00	12.00	.	9.00	12.00	12.00	9.00	12.00	9.00	8.00	12.00	9.00	12.00	6.00	12.00	8.00	9.00	12.00	11.00	12.00

Note: α : coefficient in regression (1). P-value $\alpha=0$ denote p-values for the $\alpha=0$ t-test.

Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

Table B5: Weak efficiency test

Member State	Nominal revenue				Real GDP				Indirect taxes				Direct taxes				Social contributions			
	current year		year ahead		current year		year ahead		current year		year ahead		current year		year ahead		current year		year ahead	
	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$
AT	0.54	0.08	-0.04	0.90	0.15	0.48	-0.11	0.73	-0.21	0.52	-0.57	0.06	0.25	0.43	-0.04	0.90	0.31	0.34	0.13	0.74
BE	0.37	0.22	-0.21	0.54	-0.08	0.72	-0.25	0.41	-0.27	0.23	-0.33	0.24	-0.07	0.84	-0.11	0.76	-0.04	0.89	-0.11	0.74
DE	0.65	0.01	0.31	0.34	0.28	0.29	-0.12	0.72	-0.12	0.69	-0.12	0.70	0.66	0.01	0.46	0.15	0.63	0.03	0.15	0.66
DK	0.39	0.20	-0.07	0.85	0.08	0.81	0.14	0.69	0.41	0.17	0.35	0.30	0.39	0.18	-0.18	0.59	0.09	0.83	0.07	0.85
EL	0.36	0.30	0.06	0.86	0.64	0.03	0.86	0.00	-0.01	0.98	-0.04	0.91	0.05	0.90	0.22	0.51	0.09	0.77	-0.22	0.52
ES	0.26	0.42	0.43	0.18	0.27	0.37	0.20	0.59	-0.09	0.78	0.41	0.22	0.32	0.32	0.31	0.36	0.60	0.06	0.69	0.08
FI	-0.07	0.82	-0.24	0.49	-0.13	0.66	-0.13	0.70	0.23	0.48	-0.06	0.85	-0.03	0.92	-0.16	0.62	0.08	0.76	-0.08	0.82
FR	0.21	0.52	0.04	0.91	-0.23	0.46	-0.16	0.63	-0.05	0.86	0.20	0.55	-0.03	0.92	-0.20	0.56	-0.25	0.31	-0.06	0.87
IE	0.39	0.21	0.42	0.19	-0.55	0.07	0.18	0.60	0.32	0.27	0.39	0.22	0.32	0.31	0.45	0.16	-0.61	0.03	0.56	0.05
IT	0.18	0.58	-0.03	0.94	-0.23	0.48	-0.16	0.65	0.12	0.71	0.04	0.90	0.17	0.54	-0.07	0.82	0.04	0.91	-0.03	0.94
LU	-0.21	0.53	-0.28	0.38	0.00	1.00	0.24	0.41	0.05	0.84	0.21	0.45	0.12	0.71	-0.28	0.43	-0.41	0.15	-0.37	0.22
NL	0.13	0.69	-0.06	0.86	0.29	0.20	-0.12	0.70	-0.21	0.51	-0.17	0.61	0.36	0.23	0.28	0.45	0.15	0.63	-0.02	0.95
PT	-0.36	0.25	-0.39	0.32	0.13	0.70	-0.26	0.45	0.12	0.72	-0.12	0.77	-0.17	0.52	-0.06	0.84	-0.25	0.44	0.10	0.80
SE	-0.17	0.60	-0.25	0.45	-0.04	0.89	-0.09	0.79	-0.31	0.33	-0.08	0.83	-0.38	0.19	-0.24	0.44	-0.42	0.17	-0.68	0.02
UK	-0.17	0.59	-0.34	0.30	-0.11	0.79	-0.17	0.62	-0.06	0.84	0.04	0.90	-0.17	0.58	-0.17	0.65	-0.24	0.33	-0.34	0.28
BG	0.39	0.29	-0.04	0.94	-0.13	0.45	-0.26	0.33	-0.43	0.43	-0.33	0.59	0.15	0.36	0.15	0.59	-0.03	0.95	0.05	0.93
CY	0.13	0.75	0.30	0.48	-0.80	0.08	-0.28	0.45	0.02	0.96	0.11	0.82	0.19	0.64	0.21	0.67	-0.36	0.43	-0.37	0.16
CZ	-0.16	0.65	0.13	0.73	0.26	0.42	0.12	0.72	-0.09	0.74	-0.70	0.11	-0.18	0.59	0.04	0.92	0.01	0.98	0.15	0.75
EE	0.12	0.76	0.10	0.77	0.42	0.19	0.46	0.16	-0.36	0.26	-0.05	0.91	0.45	0.14	0.38	0.41	0.49	0.18	0.30	0.51
HR	-0.01	0.94	0.19	0.70	0.30	0.45	0.19	0.67	-	-	-	-	-	-	-	-	-	-	-	-
HU	0.54	0.12	-0.26	0.55	-0.07	0.83	-0.16	0.63	-0.19	0.61	0.06	0.92	0.02	0.96	0.35	0.44	-0.32	0.32	-0.03	0.95
LT	0.14	0.69	0.01	0.98	0.21	0.51	0.11	0.74	-0.14	0.71	-0.03	0.95	0.01	0.98	-0.10	0.84	-0.14	0.71	0.41	0.39
LV	0.57	0.09	0.25	0.52	0.38	0.22	0.37	0.26	0.05	0.90	0.26	0.55	0.29	0.43	-0.01	0.98	0.36	0.31	0.30	0.52
MT	0.52	0.13	0.49	0.08	0.09	0.79	0.19	0.58	-0.69	0.05	0.13	0.70	-0.37	0.33	0.10	0.83	-0.19	0.63	-0.39	0.29
PL	0.20	0.52	0.18	0.59	-0.03	0.91	-0.07	0.79	0.05	0.88	-0.10	0.84	0.63	0.02	0.48	0.25	0.23	0.47	-0.17	0.68
RO	0.08	0.82	-0.13	0.80	-0.18	0.53	0.07	0.84	-0.15	0.78	-0.23	0.71	-0.04	0.90	0.09	0.84	-0.01	0.98	0.20	0.66
SI	-0.26	0.52	-0.02	0.96	0.04	0.90	0.05	0.90	-0.10	0.86	0.25	0.54	-0.19	0.67	0.41	0.31	0.41	0.37	-0.28	0.55
SK	0.07	0.84	-0.30	0.17	0.19	0.56	-0.03	0.94	-0.40	0.28	-0.18	0.66	-0.54	0.10	-0.11	0.82	0.02	0.96	-0.01	0.97
EA	0.29	0.30	0.13	0.71	0.08	0.68	-0.11	0.74	0.07	0.79	0.25	0.51	0.49	0.11	0.15	0.68	-0.03	0.85	-0.20	0.60
EU	-0.47	0.12	0.07	0.85	-0.34	0.28	-0.11	0.73	-0.30	0.34	0.11	0.74	0.08	0.81	0.12	0.74	-0.01	0.97	-0.17	0.63

Note: β : coefficient in regressions (5) and (6). Signif. $\beta=0$: p-value of the $\beta=0$ t-test.

Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

Table B6: Informational efficiency test

Member State	Nominal revenue				Real GDP				Indirect taxes				Direct taxes				Social contributions			
	current year		year ahead		current year		year ahead		current year		year ahead		current year		year ahead		current year		year ahead	
	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$	β	Signif. $\beta=0$
AT	-0.03	0.87	0.47	0.18	0.06	0.38	0.27	0.36	-0.21	0.59	0.11	0.70	0.22	0.26	0.38	0.21	-0.22	0.22	0.25	0.47
BE	0.13	0.48	0.09	0.80	0.20	0.06	0.27	0.35	0.51	0.02	-0.21	0.56	0.09	0.61	0.16	0.63	-0.14	0.30	0.19	0.59
DE	-0.11	0.64	0.44	0.34	0.24	0.02	0.22	0.49	0.10	0.54	0.56	0.04	-0.25	0.23	-0.05	0.89	0.07	0.79	-0.31	0.63
DK	0.13	0.64	0.09	0.78	0.08	0.55	0.10	0.71	-0.24	0.33	0.06	0.87	0.36	0.40	0.08	0.83	0.03	0.86	-0.03	0.89
EL	-0.02	0.94	-0.06	0.91	-0.17	0.04	-0.47	0.06	0.19	0.32	-0.11	0.81	-0.15	0.68	-0.01	0.98	0.06	0.75	0.19	0.63
ES	-0.19	0.37	0.00	1.00	0.03	0.63	0.08	0.75	0.19	0.45	-0.12	0.69	-0.31	0.18	0.10	0.75	-0.18	0.01	-0.39	0.04
FI	0.21	0.21	0.27	0.43	0.12	0.42	0.26	0.43	0.24	0.24	0.32	0.50	0.20	0.21	0.28	0.38	-0.21	0.17	0.11	0.70
FR	0.04	0.73	0.12	0.69	0.27	0.04	0.28	0.26	0.38	0.08	0.09	0.78	-0.02	0.93	0.05	0.89	0.25	0.19	0.45	0.13
IE	-0.21	0.33	0.12	0.71	0.08	0.58	0.21	0.35	-0.08	0.69	0.10	0.72	-0.17	0.48	0.22	0.55	-0.12	0.41	-0.48	0.06
IT	0.03	0.89	0.41	0.15	0.18	0.05	0.33	0.26	0.11	0.71	0.46	0.17	-0.15	0.44	0.13	0.60	-0.20	0.18	0.17	0.48
LU	0.22	0.30	0.29	0.41	0.32	0.12	0.36	0.24	0.23	0.33	0.50	0.14	0.28	0.43	-0.16	0.58	0.33	0.27	-0.38	0.06
NL	0.03	0.89	-0.26	0.47	0.08	0.42	0.23	0.44	0.24	0.34	-0.21	0.63	-0.01	0.97	0.61	0.22	0.00	0.98	-0.15	0.50
PT	0.08	0.63	0.80	0.04	0.34	0.04	0.23	0.52	0.00	0.99	0.13	0.70	0.34	0.14	0.59	0.08	-0.16	0.62	-0.74	0.06
SE	0.28	0.11	0.01	0.99	0.36	0.03	0.32	0.30	0.08	0.78	0.30	0.10	0.26	0.23	0.15	0.55	0.53	0.07	-0.05	0.91
UK	0.02	0.83	0.01	0.96	0.07	0.47	0.02	0.92	0.28	0.07	0.23	0.30	0.03	0.89	0.10	0.74	0.25	0.06	-0.12	0.52
BG	-0.14	0.71	0.45	0.40	0.04	0.71	0.04	0.90	0.42	0.08	-0.01	0.98	-0.12	0.79	0.44	0.40	0.13	0.46	0.44	0.27
CY	-0.12	0.70	-0.02	0.97	0.35	0.05	0.04	0.90	-0.13	0.70	0.04	0.91	-0.23	0.47	0.21	0.55	-0.09	0.72	0.31	0.44
CZ	0.16	0.48	0.19	0.50	-0.01	0.93	0.29	0.42	0.17	0.69	0.00	0.99	-0.05	0.87	-0.17	0.62	0.15	0.51	0.27	0.44
EE	-0.06	0.77	0.37	0.21	0.02	0.88	0.38	0.18	0.21	0.49	0.08	0.82	-0.24	0.12	0.50	0.07	-0.11	0.60	0.29	0.41
HR	-0.39	0.62	0.29	0.50	-0.01	0.96	0.10	0.78	2.75	.	.	.	0.99	.	.	.	-3.49
HU	0.03	0.82	0.31	0.57	0.16	0.08	-0.07	0.79	0.33	0.03	-0.11	0.77	-0.16	0.31	0.26	0.42	0.22	0.27	0.25	0.36
LT	0.09	0.59	0.19	0.57	0.06	0.62	0.27	0.37	0.34	0.06	0.38	0.28	0.00	0.99	0.06	0.87	-0.34	0.08	0.03	0.89
LV	-0.06	0.73	0.37	0.19	0.04	0.79	0.30	0.26	0.22	0.34	0.44	0.16	-0.02	0.91	0.34	0.27	-0.01	0.95	0.52	0.06
MT	-0.23	0.04	-0.43	0.35	0.33	0.16	0.20	0.65	0.43	0.17	0.00	1.00	-0.01	0.97	0.42	0.39	0.34	0.35	0.40	0.29
PL	0.10	0.72	0.18	0.56	0.16	0.43	0.23	0.39	0.29	0.31	0.23	0.61	-0.38	0.07	0.08	0.79	0.14	0.62	0.28	0.53
RO	0.31	0.02	0.32	0.51	0.00	0.98	0.10	0.76	0.48	0.16	0.30	0.51	-0.14	0.41	0.38	0.32	0.03	0.91	-0.08	0.80
SI	0.03	0.82	0.07	0.83	0.02	0.88	0.17	0.62	0.05	0.88	-0.13	0.71	-0.14	0.27	-0.28	0.50	-0.31	0.00	-0.19	0.66
SK	-0.47	0.23	-0.15	0.65	0.06	0.54	0.36	0.27	0.18	0.51	0.24	0.44	0.04	0.83	0.07	0.82	0.02	0.97	0.24	0.58
EA	0.08	0.64	0.38	0.26	0.23	0.01	0.30	0.30	0.22	0.34	0.27	0.42	-0.12	0.55	0.35	0.28	0.07	0.48	0.11	0.70
EU	0.13	0.37	0.34	0.31	0.34	0.12	0.26	0.36	0.33	0.06	0.30	0.36	-0.04	0.80	0.34	0.29	0.18	0.49	0.23	0.49

Note: β : coefficient in regressions (5) and (6). Signif. $\beta=0$: p-value of the $\beta=0$ t-test.
Numbers below 0.05 indicate a probability of serial correlation greater or equal to 95% (light grey shaded cells).

ANNEX C: Comparison with OECD forecasts

2003 - 2007 Nominal Revenue, current year									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-0.69	-0.81	0.12	1.38	1.42	0.05	1.51	1.60	0.08
BE	-1.31	-2.06	0.75	1.31	2.06	0.75	1.59	2.29	0.70
DE	-0.28	-0.24	0.05	1.39	1.57	0.18	1.62	1.72	0.10
DK	-0.92	-1.41	0.49	2.18	1.97	0.21	2.68	2.54	0.14
EL	-1.15	-0.80	0.35	1.69	2.68	0.98	1.89	3.22	1.33
ES	-2.38	-2.29	0.09	2.38	2.29	0.09	2.41	2.45	0.05
FI	-0.88	-1.12	0.23	1.89	1.65	0.24	2.11	2.06	0.06
FR	-0.58	-0.56	0.02	1.02	0.76	0.26	1.16	0.92	0.24
IE	-3.96	-3.80	0.16	4.75	4.78	0.03	5.32	5.15	0.17
IT	-2.43	-1.59	0.84	2.43	1.66	0.77	3.05	2.15	0.90
LU	-2.02	-1.79	0.23	2.17	1.86	0.31	2.57	2.38	0.19
NL	-2.18	-1.17	1.01	2.55	1.78	0.78	2.91	1.89	1.02
PT	-2.43	-0.83	1.61	2.43	1.05	1.38	3.16	1.13	2.03
SE	-1.21	-1.76	0.55	1.21	1.76	0.55	1.60	1.98	0.38
UK	-0.57	-0.48	0.09	0.86	0.94	0.08	0.97	1.02	0.05
CZ	-3.90	-1.23	2.67	4.22	2.18	2.05	4.81	2.74	2.07
EE									
HU	-2.49	-4.91	2.42	2.54	4.91	2.38	3.45	5.34	1.89
PL	-0.86	-1.51	0.65	2.88	2.53	0.35	3.27	2.76	0.51
SI									
SK	-3.08	-4.75	1.67	3.08	8.06	4.98	3.91	9.51	5.60
EA	-1.24	-0.91	0.32	1.25	0.93	0.33	1.59	1.28	0.31

2003 - 2007 Nominal Revenue, year-ahead									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-1.78	-1.75	0.03	1.78	1.75	0.03	1.92	1.98	0.06
BE	-0.11	-0.62	0.52	1.06	0.62	0.44	1.18	0.66	0.51
DE	-0.68	-0.88	0.20	1.67	2.06	0.39	2.14	2.40	0.26
DK	-1.46	-1.36	0.10	2.15	2.30	0.15	2.42	2.62	0.20
EL	-0.98	-3.21	2.23	2.31	4.01	1.70	2.58	5.65	3.07
ES	-2.98	-2.52	0.46	2.98	2.52	0.46	3.05	2.63	0.42
FI	-1.58	-2.17	0.59	1.58	2.17	0.59	2.19	2.45	0.26
FR	-1.02	-1.03	0.01	1.14	1.09	0.05	1.29	1.26	0.03
IE	-1.88	-3.31	1.43	3.91	5.11	1.19	4.53	5.49	0.96
IT	-1.63	-0.93	0.70	2.25	1.95	0.30	3.15	2.47	0.67
LU	-2.52	-2.28	0.24	2.52	2.28	0.24	2.89	2.65	0.24
NL	-2.92	-2.10	0.82	2.92	2.51	0.41	3.15	2.90	0.25
PT	-0.66	-0.93	0.27	2.34	3.01	0.67	2.52	3.35	0.83
SE	-0.81	-1.38	0.57	0.81	1.38	0.57	1.19	1.67	0.48
UK	-1.03	-1.14	0.11	1.03	1.14	0.11	1.31	1.20	0.10
CZ	-1.22	-0.33	0.89	1.92	1.44	0.47	2.26	1.90	0.36
EE									
HU	-1.49	-1.53	0.04	2.31	2.79	0.48	3.07	3.61	0.54
PL	-4.76	-2.63	2.12	4.76	2.72	2.03	4.77	3.15	1.62
SI									
SK	-0.55	-0.29	0.26	3.74	2.59	1.16	4.87	3.50	1.37
EA	-1.34	-1.28	0.06	1.34	1.28	0.06	1.81	1.72	0.09

2008 - 2010 Nominal Revenue, current year									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-0.93	-1.54	0.61	1.00	1.54	0.54	1.22	1.65	0.43
BE	0.57	0.05	0.51	0.57	1.01	0.45	0.76	1.16	0.41
DE	-2.14	-1.52	0.61	2.14	1.52	0.61	2.40	1.77	0.63
DK	-0.89	-2.14	1.25	1.49	2.81	1.32	2.06	3.55	1.49
EL	4.66	4.47	0.19	4.66	4.47	0.19	5.24	5.27	0.03
ES	5.18	5.49	0.31	5.18	5.95	0.78	6.20	7.12	0.92
FI	0.58	1.14	0.56	2.00	2.78	0.78	2.49	2.94	0.45
FR	0.61	0.78	0.18	0.84	1.36	0.52	0.91	1.50	0.59
IE	5.99	5.42	0.57	5.99	5.42	0.57	7.11	7.37	0.26
IT	0.36	1.01	0.64	0.52	1.01	0.50	0.55	1.31	0.75
LU	-3.86	-2.99	0.87	3.86	2.99	0.87	4.01	3.20	0.82
NL	-1.67	-0.51	1.15	1.67	1.02	0.65	1.82	1.21	0.61
PT	2.13	0.52	1.61	2.37	2.63	0.26	2.84	2.68	0.16
SE	-1.08	-1.72	0.64	1.90	2.13	0.23	1.98	2.39	0.41
UK	-0.99	-1.44	0.45	1.33	1.44	0.10	1.57	1.57	0.01
CZ	2.76	3.38	0.62	3.24	3.38	0.14	3.90	3.83	0.07
EE									
HU	-1.87	0.00	1.87	1.87	0.55	1.33	2.62	0.60	2.02
PL	0.34	2.40	2.06	1.04	2.40	1.36	1.28	2.65	1.36
SI									
SK	-1.16	1.66	2.82	1.16	2.87	1.71	1.16	3.23	2.06
EA	0.13	0.91	0.79	1.00	1.76	0.76	1.10	1.79	0.70

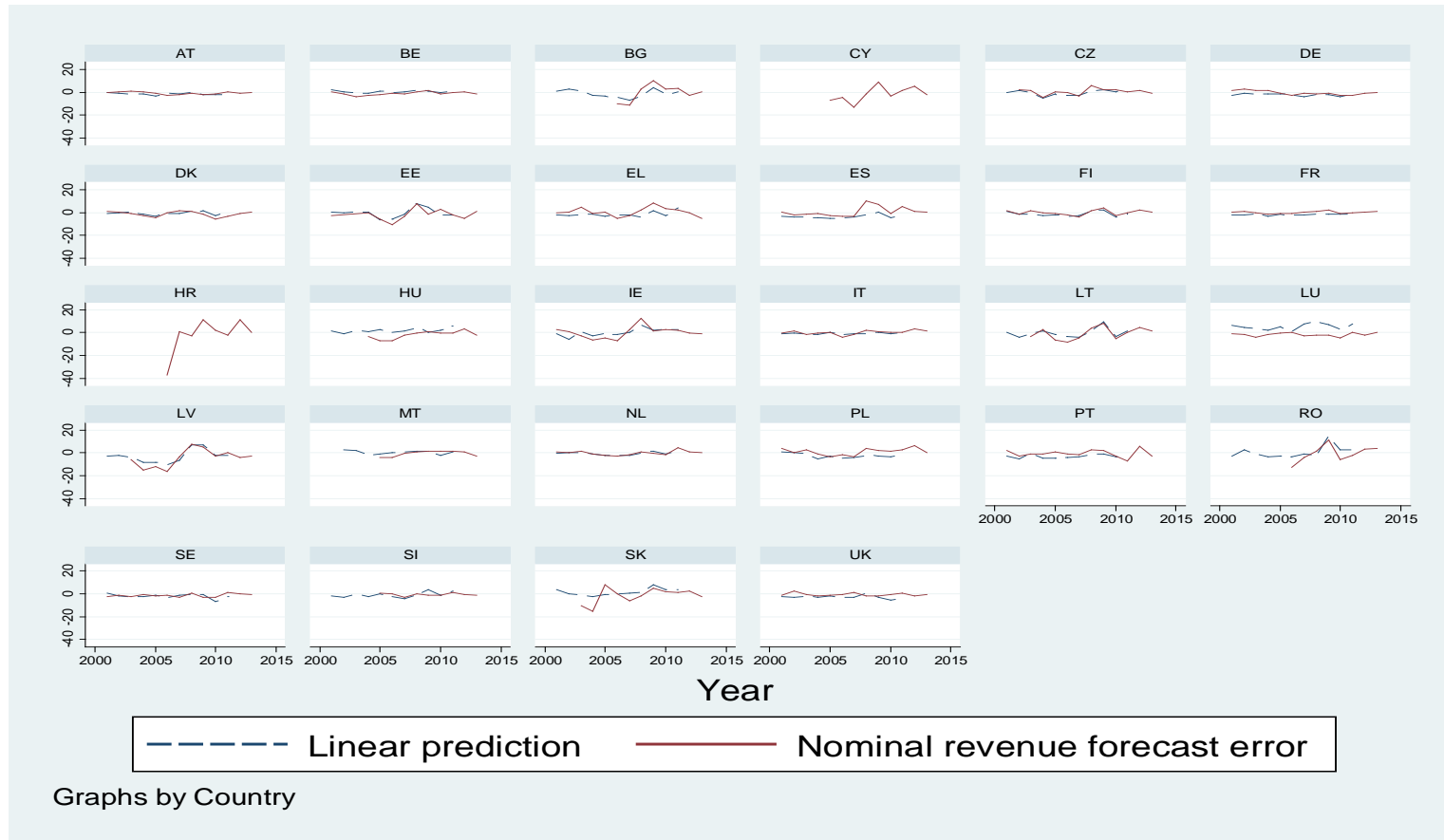
2008 - 2010 Nominal Revenue, year-ahead									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-0.51	0.80	1.31	1.82	2.63	0.81	2.25	3.32	1.07
BE	0.48	0.75	0.27	3.16	3.18	0.01	3.78	3.89	0.12
DE	-0.36	0.58	0.94	1.78	2.63	0.85	2.09	3.14	1.05
DK	-0.48	0.05	0.54	3.23	3.26	0.03	3.89	3.62	0.27
EL	5.79	4.74	1.05	5.79	5.49	0.29	7.83	7.52	0.31
ES	7.79	7.92	0.13	7.79	7.92	0.13	8.98	9.55	0.57
FI	3.01	2.39	0.63	4.11	4.33	0.22	5.85	5.74	0.12
FR	1.18	2.19	1.01	2.78	2.82	0.04	3.32	3.87	0.55
IE	9.21	8.92	0.29	9.21	10.02	0.81	10.77	11.66	0.89
IT	1.98	2.28	0.30	1.98	2.32	0.34	2.41	2.85	0.43
LU	-0.80	-0.18	0.61	3.04	3.37	0.34	3.59	4.09	0.50
NL	0.95	2.28	1.33	3.22	3.76	0.54	3.98	4.98	1.00
PT	1.21	1.06	0.15	7.52	5.46	2.06	8.68	5.76	2.92
SE	1.14	0.78	0.36	3.45	3.12	0.32	3.45	3.16	0.29
UK	3.05	1.68	1.37	4.49	4.77	0.28	6.60	5.90	0.70
CZ	5.33	5.79	0.45	5.33	5.79	0.45	5.87	6.26	0.38
EE									
HU	0.67	2.56	1.89	1.54	2.71	1.17	1.89	3.46	1.57
PL	0.98	3.10	2.12	4.46	3.32	1.14	4.76	5.50	0.74
SI									
SK	4.21	5.48	1.27	5.24	5.79	0.54	8.23	7.69	0.55
EA	1.78	2.44	0.66	2.84	3.41	0.57	3.23	4.06	0.83

2011- 2013 Nominal Revenue, current year									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-0.30	-0.15	0.15	0.56	0.27	0.29	0.63	0.34	0.30
BE	-0.64	-0.17	0.47	1.08	0.59	0.49	1.26	0.59	0.67
DE	-1.54	-1.36	0.19	1.54	1.36	0.19	1.84	1.36	0.48
DK	-0.38	-1.28	0.91	0.83	1.45	0.61	0.91	1.45	0.53
EL	1.65	-1.02	2.67	4.80	2.38	2.42	5.08	2.38	2.70
ES	3.10	2.14	0.96	3.10	2.14	0.96	3.53	2.14	1.39
FI	0.28	0.68	0.40	1.79	0.89	0.91	1.81	0.89	0.93
FR	-0.68	0.23	0.91	0.68	0.54	0.15	0.69	0.54	0.15
IE	-0.15	0.25	0.39	0.49	1.00	0.52	0.51	1.00	0.50
IT	2.03	1.70	0.34	2.03	1.70	0.34	2.06	1.70	0.36
LU	-1.24	-0.62	0.62	1.53	0.84	0.69	1.96	0.84	1.13
NL	1.16	1.70	0.54	1.16	1.70	0.54	1.41	1.70	0.29
PT	-2.45	-1.44	1.00	5.37	5.20	0.17	5.90	5.20	0.71
SE	1.47	0.51	0.96	1.47	0.79	0.68	1.53	0.79	0.74
UK	0.02	-0.59	0.62	2.05	1.02	1.03	2.05	1.02	1.03
CZ	1.48	0.44	1.04	1.48	0.84	0.64	1.64	0.84	0.80
EE	-6.01	-2.05	3.96	6.01	2.72	3.29	6.02	2.72	3.30
HU	0.80	0.22	0.57	0.80	1.90	1.10	0.86	1.90	1.04
PL	4.08	3.00	1.08	4.08	3.00	1.08	4.28	3.00	1.28
SI	1.87	-0.09	1.96	1.87	1.15	0.72	1.90	1.15	0.75
SK	2.47	0.42	2.05	2.47	1.93	0.54	2.77	1.93	0.84
EA	0.11	0.31	0.20	0.26	0.31	0.05	0.28	0.31	0.03

2011- 2013 Nominal Revenue, year-ahead									
MS	ME OECD	ME EC	ME DIFF	MAE OECD	MAE EC	MAE DIFF	RMSE OECD	RMSE EC	RMSE DIFF
AT	-0.45	-1.01	0.56	0.45	1.01	0.56	0.57	1.01	0.44
BE	-1.34	-1.84	0.51	1.34	1.84	0.51	1.39	1.85	0.45
DE	-2.37	-1.88	0.49	2.37	1.88	0.49	2.58	2.24	0.34
DK	0.58	1.27	0.69	0.99	1.27	0.27	1.15	1.46	0.31
EL	4.50	3.73	0.77	4.50	3.73	0.77	4.53	3.95	0.58
ES	2.54	2.59	0.05	2.54	2.59	0.05	3.33	3.18	0.16
FI	0.58	0.55	0.03	2.16	1.67	0.49	2.23	1.76	0.47
FR	-1.51	-0.20	1.31	1.51	0.20	1.31	1.76	0.28	1.48
IE	2.17	-0.23	2.40	3.13	0.43	2.70	3.81	0.49	3.32
IT	2.05	0.97	1.09	2.05	0.97	1.09	2.08	1.25	0.83
LU	-2.47	-0.19	2.27	2.47	0.30	2.16	3.38	0.36	3.01
NL	2.89	3.46	0.57	2.89	3.46	0.57	2.99	3.60	0.61
PT	0.64	0.82	0.18	6.80	8.23	1.43	6.83	8.27	1.44
SE	1.89	0.78	1.11	1.89	0.78	1.11	1.96	0.93	1.02
UK	-1.51	-0.42	1.09	1.88	0.55	1.34	2.42	0.69	1.73
CZ	2.39	1.38	1.01	2.39	1.59	0.80	2.45	2.11	0.34
EE	-9.27	-4.04	5.24	9.27	4.04	5.24	9.27	4.04	5.24
HU	-8.89	-9.64	0.74	11.80	14.87	3.07	14.77	17.71	2.94
PL	2.67	0.68	1.99	3.85	2.54	1.31	4.68	2.63	2.06
SI	2.28	2.23	0.05	2.28	2.23	0.05	2.40	2.36	0.04
SK	0.04	0.87	0.84	1.23	0.87	0.35	1.23	0.89	0.34
EA	-0.05	0.09	0.14	0.35	0.41	0.06	0.35	0.42	0.07

ANNEX D: The fitted value of forecast errors by country

Figure D1: The fitted value of nominal revenue forecast error



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