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REVENUE FORECAST ERRORS IN THE EUROPEAN UNION

RUI MIGUEL DA COSTA CARVALHO

SUPERVISOR: PROFESSOR ANTÓNIO AFONSO

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Rui Carvalho

Supervisor: António Afonso

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Abstract

The recent years had brought significant uncertainty to macroeconomic forecasts made not only by specialized international institutions but also by central governments. This dissertation assesses the determinants of revenue forecast errors for the EU-15 between 1999 and 2012, based on the forecasts published bi-annually by the European Commission. A particular important result obtained was that tax rate changes do affect revenue errors and that different tax changes affect differently revenue errors. Also, GDP errors, minority governments, election year and corporate rate changes can be associated to overly optimistic revenue forecasts. On the other hand, 10-year bond yields, inflation errors and VAT changes are associated with a more prudent behaviour.

Keywords: macro forecasts, revenue forecast errors, EU

JEL: C23, H20, H68

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Contents

1. Introduction

The recent years brought significant uncertainty to macroeconomic forecasts made not only by international institutions but also by central governments. This fact was visible notably when the Organisation for Economic Co-operation and Development (OECD) fiscal outlook, for a wide range of countries, showed that tax revenue was much lower than officially predicted by the beginning of the financial crisis in 2008 (Buettner & Kauder, 2010; Golosov & King, 2002). This fact was also recently brought to light in the Report of Central Administration Budget Execution for 2012 elaborated by the Portuguese Court of Auditors (2013), where the recent evolution of the value added tax (VAT) raised doubts about the sustainability of forecasts[1].

Nonetheless, making precise revenue forecasts is not an easy job. To predict revenue, a bundle of variables is needed to take into account, from the most basic macroeconomic variables, as gross domestic product (GDP) or inflation, to fiscal policy, tax structures, and, perhaps the most difficult one to model, people's behavior towards the uncertainty.

One of the reasons why the forecasts have a key role in the economy are the expectations generated by them. Macroeconomic data may take a few years until it becomes definite, so meanwhile, forecasts are the best existing values and the ones taken into account by investors when it comes to evaluate the capability of a country to face their responsibilities. Moreover, as identified by Esteves and Braz (2013) access to reliable information on the economic situation is fundamental for policy makers since the results of their actions depend on the quality of the available information.

In this dissertation, we study the variables pointed out by the literature as possible to influence the performance of the revenue forecast. For that purpose, a panel data set was

[1] According to the report, the 2012 government budget forecasts an increase of 12.6% of VAT that in reality turn out to be a decrease of 2%.

constructed based on the biannual reports made by the European Commission (EC), from 2000 spring up to 2013 spring, for the European Union (EU) 15 countries namely Austria (AT), Belgium (BE), Germany (DE), Denmark (DK), Spain (ES), Finland (FI), France (FR), Greece (GR), Ireland (IE), Italy (IT), Luxembourg (LU), Netherlands (NL), Portugal (PT), Sweden (SW) and United Kingdom (UK). Later, a seemingly unrelated regression (SUR) analysis for each country will be performed in order to identify possible cross-country differences.

As expected, GDP and inflation are statistically significant in the estimated regressions. However, this is only true for some of the forecasting horizons. Also, political variables such as coalition governments, election year and single party minority governments came out as important. Moreover, dummies controlling for tax changes also play a key role when it comes to explaining revenue errors.

This dissertation is divided in the following sections. Section 2 reviews the literature about forecast errors, mainly on the revenue side. Section 3 explains the methodology. Section 4 describes the data set. Section 5 reports and discusses the results. Finally, section 6 is the conclusion.

2. Literature review

By the time Golosov and King (2002) performed their study, the main focus of the literature concerning forecast errors were the ones around the forecast of the GDP growth rate. However, and recognizing that having accurate revenue data is fundamental in order to elaborate a good budget, countries and authorities have made efforts to obtain reliable numbers for the expected revenues (Buettner & Kauder, 2010), and so the discussion around this issue is increasing. Nevertheless, the majority of the existing literature about revenue forecasting concerns the USA(Buettner & Kauder, 2010; Golosov & King, 2002).

Nevertheless, it was not the first time that revenue forecast errors were used as an attempt to explain a crisis. According to Auerbach (1995) some economists were trying to explain the ongoing fiscal crisis on the USA by looking at tax changes in the 1980s and early 1990s. Based on the Office of Management and Budget (OMB) annual budget forecasts, the author explained the deviations of revenue using an unusual approach, by trying to explain the determinants of technical errors. The results supported the idea that overly optimistic revenue forecasts from 1980s were partially caused by unforeseen reactions from taxpayers.

Indeed, according to Auerbach (1999) and Breuer (2013), uncertainty surrounding forecast errors was driven by economic, policy and technical errors. Economic errors were associated to unpredicted changes in macroeconomic variables, like GDP. Policy errors may be caused by changes on the tax rates or on the law, e.g. Finally, technical errors are the remaining part and they are frequently connected to various changes that were not considered neither political nor economic.

Cimadomo (2011), in his literature survey about real-time data and fiscal policy analysis, identified that frequent and sizeable revisions of fiscal data, as well as large deviations of fiscal outcomes from the initial forecasts, are factors that endanger the EU's surveillance mechanism. Model uncertainty or unexpected shocks, are pointed out by the author as the main reasons for fiscal outcomes deviations' from government plans. Upcoming political elections are also mentioned as possibly inducing over-optimism in fiscal projections.

Buettner and Kauder (2010) studied revenue forecasts performance for 12 OECD countries. They argued that cross-country differences in revenue forecasting performance were mainly caused by the uncertainty about basic macroeconomic variables, corporate and personal income tax structures, the elapsed time between the forecast and the observation of the variables, and the independence of forecasts from possible government manipulation.

Golosov and King (2002), wrote about one year-ahead forecasts of tax revenues in the International Monetary Fund (IMF) programs for a bundle of low income countries. The authors mentioned that the latest studies (at the time) did not found any link between forecasting errors and political factors. They also report that underestimates of next year's fiscal deficit would be much more expensive than overestimating by the same value. As a consequence, it was suggested that since fiscal deficit underestimation is more expensive then overestimation, the deviation should occur to the cheaper side. In the context of an IMF program, major changes to the tax system may take place and those changes may introduce additional uncertainty to the tax revenue forecasts.

Using data from the annual Stability and Convergence Programs, for the EU-15 countries, Hagen (2010) studied the deviations between project and actual outcomes for

a bundle of variables, namely GDP growth, general government balance, revenue and expenditure relative to GDP. The author found not only problems in the forecasting performance of the EU country governments but also bias and inefficiency on projections. As a consequence, Hagen (2010) says that this facts may let us think about the capability of governments to carry out accurate forecasts, as well as their availability to reveal all the detained information.

A new perspective was brought by Pina and Venes (2011). The authors studied the general government budget balance forecasts for the EU-15 countries, based on the information reported in the Excessive Deficit Procedure (EDP). They found that forecast errors are sensible to growth surprises, fiscal institutions and opportunistic motivations, namely the proximity to an election may induce over-optimistic forecasts. On the contrary, commitment, mix forms of fiscal governance and numerical expenditure rules are frequently linked to higher carefulness when it comes to forecasts.

Brück and Stephan (2006) used bi-annual forecasts of EC between 1995 and 2003 for the EU-15, Japan and USA. Their aim was to explain the deviations in the existing budget deficits, using political, electoral, and institutional variables. They come to the conclusion that, Stability and Growth Pact (SGP) influences the quality of budget deficit forecasts, especially in the period prior to elections.

A literature survey by Leal, Pérez, Tujula, and Vidal (2008) regarding the main issues and challenges about fiscal forecasting, finds that in the worst periods of budget balance projections appeared to be more optimistic whereas, negative projections emerged in times of good budget balances.

Table I – Summary of literature

Cimadomo (2011)
Goal: literature survey about real-time data and fiscal policy. **Conclusions:** early estimates are biased values of final values; Upcoming elections may induce over-optimism projections; model uncertainty or unexpected shocks cause fiscal outcomes deviations' from government plans.
Pina and Venes (2011)
Data: based on EDP for EU-15. **Goal:** study the determinants of EDP forecast errors. **Conclusions:** forecast errors are sensible to growth surprises, fiscal institutions and opportunistic motivations; proximity to an election may induce over-optimistic forecasts; Commitment, mix forms of fiscal governance and numerical expenditure rules are frequently linked to higher carefulness
Buettner and Kauder (2010)
Data: official tax-revenue forecasts for 12 OECD countries. **Goal:** study cross-country revenue forecast performance. **Conclusions:** cross-country differences in revenue forecasting caused by: uncertainty around macroeconomic variables; tax structures; elapsed time between forecast and observation of the variables; independence of forecasts.
Hagen (2010)
Data: SPG, for the EU-15 countries. **Goal:** study the role of institutions on projection errors. **Conclusions:** found problems in forecasting performance of the EU country governments as well as bias and inefficiency on projections.
Leal, Pérez, Tujula, and Vidal (2008)
Goal: access main issues and challenges about fiscal forecasting. **Conclusions:** worst periods of budget balance projections appeared to be more optimistic whereas, negative projections emerged in times of good budget balances.
Brück and Stephan (2006)
Data: bi-annual EC forecasts from 1995 to 2003, for EU-15, USA and Japan. **Goal:** find political, electoral and institutional determinants of budget deficit forecasts. **Conclusions:** SGP influences the quality of budget deficit forecasts, especially in the period prior to elections.
Golosov and King (2002)
Data: IMF's Monitoring of Fund Arrangements database; 45 countries under IMF programs. **Goal:** study precision of revenue forecasts for countries under an IMF program. **Conclusions:** since fiscal deficit underestimation is more expensive then overestimation, deviation should occur to the cheaper side.
Auerbach (1995)
Data: OMB forecast errors between 1982-1993. **Goal:** explain technical forecast errors. **Conclusions:** overly optimistic revenue forecasts from 1980s were partially caused by unforeseen reactions from taxpayers.

In sum, the literature has already identified possible outcomes for having inaccurate forecasts. However, the results seem to vary across time and country. Table I summarizes some of the abovementioned main findings.

3. Methodology

Since we want to address forecast errors, it is essential to enlighten this concept. Following the literature (Afonso & Silva, 2012; Hagen, 2010; Pina & Venes, 2011) it is considered a forecast error the difference between the variable outturn and the variable forecast, where *i* stands for the country and *t* for the corresponding forecast period,

$$(1)\ e_{i;t} = outturn_{i;t} - forecast_{i;t}.$$

Thus, positive values for errors are the result of a better than projected performance, while a negative value represents an overly optimistic forecast. Note that, it is considered as outturn, for period *t*, the first available estimates published by the EC on *t+1* spring.[2]

4. Empirical and variables analysis

4.1 European Commission Forecasts

This part of the work is devoted to the analysis of revenue forecasts prepared by the EC for the EU-15. Hence, our main data source are the bi-annual reports published by the EC, between 1999 spring and 2013 spring. The data were collected for years *t*, *t+1* and *t+2* for GDP growth in volume, for the private consumption price deflator, general government total revenue as percentage of GDP, plus the first available estimates for these same variables. Subsequently, and using the methodology explained above in (1), our main variables were constructed, namely the GDP error, inflation error and revenue as a percentage of GDP.

[2] We follow the reasoning assumed by Brück and Stephan (2006) and Pina and Venes (2011) that the first variable's estimates are the basis for political corrections. Moreover, they allow us to avoid methodological revisions.

From the Annual Macroeconomic database of the EC (AMECO), general government consolidated gross debt (DEBT) was used along with general government balance (BAL) and the gap between actual and potential GDP (GAP). The 10-year bond yield value is taken from Eurostat's European Monetary Union (EMU) convergence criterion series. Standard & Poor's volatility 500 index (VIX) was taken from yahoo finance and used later as instrumental variable.

Using a political database from Armingeon, Weisstanner, Engler, Potolidis, and Gerber (2012)[3], a set of dummies was used in order to control for political influences, specifically, coalition governments' (Coalition), legislative elections on the present year (Election year) and minority governments composed by one party (Minority Gov).

Since 1990, the EC performs a survey across the member states, in order to assess what kind of numerical fiscal rules are used – budget balance, revenue, expense, among others. According to the EC, the purpose of these rules is to increase fiscal discipline and serve as an instrument for policy coordination between member states, furthermore reducing the uncertainty on fiscal policy. Thus, the variable fiscal rule index (FRI) is also used in order to check whether such rules have any influence on revenue predictions.

Finally, in order to capture the uncertainty brought by changes in tax rates and in the law, a series of dummies was used. Generally, they assume the value 1 when a change in the tax rate relative to previous year occurs and 0 in the opposite case. Thus, we can account for changes to VAT rates, changes to the personal income tax rate, changes to corporate rate and changes to social security tax rates. Apart from these, there are also dummies for each of the taxes that indicate whether if the observed changed was due to

[3] Data for 2011 was kindly provided by the authors, while the 2012 information was calculated based on www.parlagov.org/ and on the same methodology.

an increase or decrease of the rate, which allow ascertain more precisely the impact of each change. All these variables were based on the OECD Tax Database, except for the VAT.[4]

Table II - Dummy distribution, by tax type, country and direction of change

	Corporate rate			VAT rate			Income rate			Soc. Security rate		
Country	**Δ**	**up**	**down**	**Δ**	**up**	**down**	**Δ**	**up**	**down**	**Δ**	**up**	**down**
AT	1	0	1	0	0	0	5	3	2	1	0	1
BE	1	0	1	1	1	0	1	0	1	0	0	0
DK	3	0	3	0	0	0	10	3	7	2	1	1
FI	2	0	2	3	3	0	12	2	10	11	7	4
FR	5	0	5	2	1	1	7	3	4	9	5	4
DE	4	1	3	1	1	0	7	1	6	14	4	10
GR	7	0	7	3	3	0	8	2	6	4	4	0
IE	3	0	3	11	8	3	3	0	3	7	3	4
IT	4	0	4	1	1	0	6	3	3	1	1	0
LU	3	1	2	0	0	0	5	2	3	8	4	4
NL	5	0	5	2	2	0	14	7	7	6	4	2
PT	2	0	2	5	4	1	6	4	2	0	0	0
ES	2	0	2	2	2	0	5	2	3	1	0	1
SW	1	0	1	0	0	0	3	1	2	1	1	0
UK	3	0	3	3	2	1	4	2	2	5	3	2
Total	**46**	**2**	**44**	**34**	**28**	**6**	**96**	**35**	**61**	**70**	**37**	**33**
Period	2000 to 2012	2000 to 2012	2000 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012	1999 to 2012

Source: OECD Tax database and authors' calculations.

Table II shows that changes to personal income rates are the most frequent ones, whereas changes to VAT are the less frequent. In fact, there are only 2 decreases of corporate tax rates contrasting with decreases on income tax rates.

Overall, the main reason for choosing all the above mentioned variables is because they are the most used in the literature, not only to study revenue deviations but also on related studies about other macroeconomic variables, like expenditure, deficit, GDP.

[4] European Commission (2013).

Table III – Summary of authors who have used these variables

GDP forecast error
Afonso and Silva (2012); Pina and Venes (2011); Buettner and Kauder (2010); Becker and Buettner (2007); Brück and Stephan (2006); Golosov and King (2002)
Election year
Pina and Venes (2011); Hagen (2010); Becker and Buettner (2007); Brück and Stephan (2006); Castro, Pérez, and Rodríguez-Vives (2011)
Inflation error
Afonso and Nunes (2013); Afonso and Silva (2012); Golosov and King (2002)
FRI
Afonso and Nunes (2013); Pina and Venes (2011); Hagen (2010)
Minority Gov
Pina and Venes (2011); Brück and Stephan (2006)
Coalition
Pina and Venes (2011); Brück and Stephan (2006)
BAL
Afonso and Nunes (2013)
DEBT
Afonso and Nunes (2013)
GAP
Pina and Venes (2011)
VIX
Afonso and Nunes (2013)
Tax modifications
Auerbach (1995)

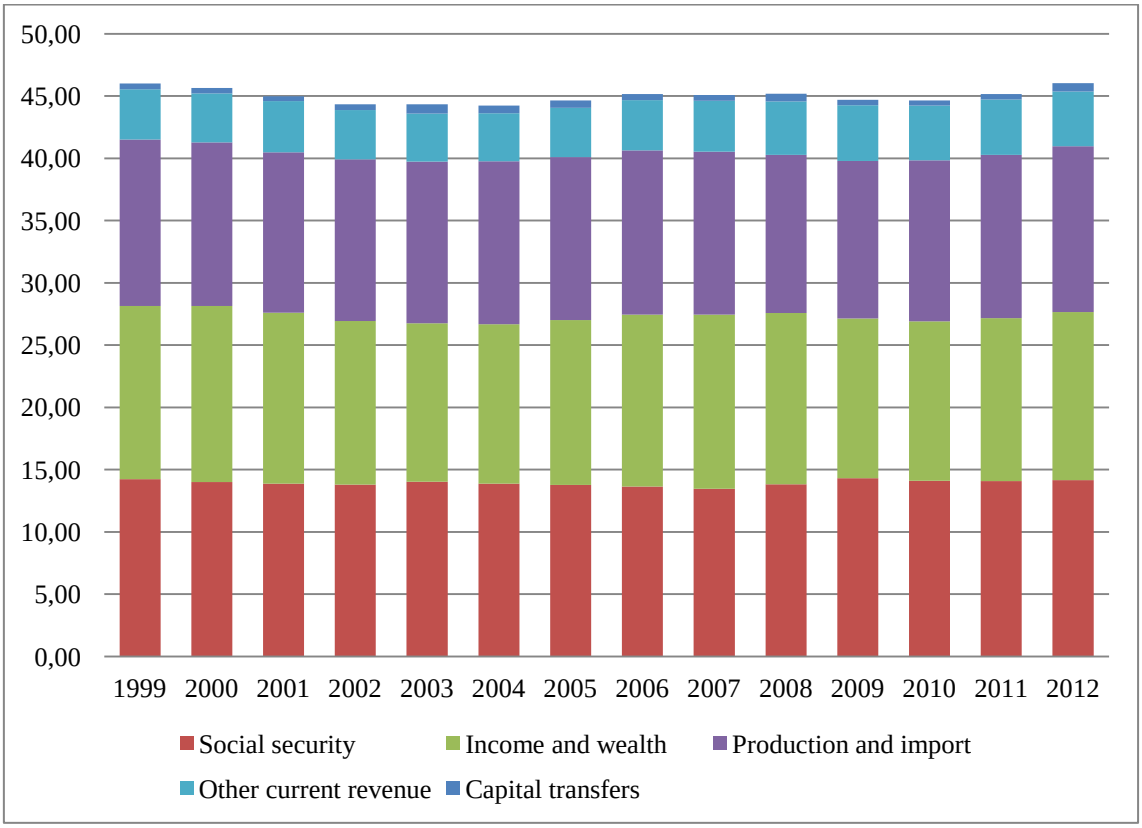
Table III exemplifies some of the authors using the above described variables, or similar, in studies related with forecast errors. Thus, using this set of variables, which can be classified as economic, political and technical, we assess their explanatory power for each of the types of errors associated with the literature for errors revenue forecast.

In addition, it is important to stress which components contribute for the general government's total revenue. EC follows the European System of Accounts 95 (ESA95) nomenclature[5]. Hence, total revenue is the sum of taxes on production and imports (D.2), other subsidies on production (D.39), property income (D.4), current taxes on

[5] See Annex of regulation Nº 1221/2002 of the European Parliament and of the Council of 10 June 2002

income and wealth (D.5), social contributions (D.61), other current transfers (D.7) and capital transfer (D.9).

Figure 1 - Annual total revenue for EU-15, per type, as a percentage of GDP at market prices from EDP



Source: AMECO.

As depicted on figure 1, total revenue as a percentage of GDP represents, since 1999 until the present, nearly 45% of the total GDP for the EU-15. Note that, the highest contributions are given by social security contributions, income and wealth taxes and production and import.

Table IV – Descriptive statistics for revenue error, as a percentage of GDP

Country	Total revenue error for period *t*			Total revenue error for period *t+1*			Total revenue error for period *t+2*		
	Mean	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**	**Mean**	**Std. Dev.**	**Obs.**
AT	0.22	0.69	28	0.65	1.32	26	0.58	1.72	12
BE	0.42	0.73	28	0.81	1.00	26	0.93	1.10	12
DE	0.19	0.59	28	0.38	1.10	26	0.29	1.29	12
DK	0.92	1.05	28	1.41	1.38	26	1.83	1.38	12
ES	-0.25	1.04	28	-0.67	1.68	26	-0.90	1.84	12
FI	0.39	0.89	28	1.22	1.14	26	1.67	1.36	12
FR	0.05	0.67	28	0.23	1.14	26	0.34	1.49	12
GR	-0.40	2.47	28	-0.15	3.23	26	-0.53	2.55	12
IE	0.44	1.73	28	0.63	2.22	26	0.53	1.85	12
IT	0.03	0.66	28	0.40	0.88	26	0.55	0.84	12
LU	-0.05	1.77	28	-0.03	3.01	26	-0.13	3.22	12
NL	0.07	0.76	28	0.14	1.03	26	0.03	1.21	12
PT	-0.13	1.60	28	-0.46	1.68	26	-0.68	1.56	12
SE	0.23	1.20	28	0.25	1.44	26	0.10	1.65	12
UK	0.19	0.81	28	0.15	1.23	26	-0.19	0.96	12
EU-15	**0.15**	**1.25**	**420**	**0.33**	**1.77**	**390**	**0.29**	**1.80**	**180**

Source: European Commission.

Table IV shows the descriptive statistics for our dependent variable, the revenue error as a percentage of GDP, for all EU-15 countries. Observing the mean value for EU-15 we conclude that for all periods, realized revenue has been, on average, higher than forecasts, suggesting the existence of ex-ante prudent behavior. In practice, revenue outturn was, on average, 0.15 percentage points higher than forecasted for *t*, 0.33 percentage points higher for *t+1* and 0.29 percentage points higher for *t+2*. However, this is not true for all EU-15 countries. Greece, Portugal, Spain and Luxembourg exhibit negative means for all the periods, in other words, forecast revenue were overly optimistic. In addition, for Portugal and Spain, the longer is the forecasted period, the higher the error, on average. This behavior is not shared by Luxembourg and Greece, where *t+1* forecasts emerge as the most accurate ones, on average. Besides those countries, only the United Kingdom reveals a negative forecast mean for *t+2*. Nevertheless, if we make an average per country for the three periods, the United

Kingdom emerges as the country with most accurate forecasts, followed by Luxembourg and the Netherlands. On the opposite side, Denmark, Finland and Belgium are the ones with most inaccurate forecasts, even though they all under predict revenue (see table A.1, on appendix). Another finding, on the contrary of what would be expected, is that mean deviations for EU-15, for *t* are indeed lower then *t+1*, but the same does not happen for *t+2*, which are lower, and closer to *t* forecasts. Forecasts for period *t+1* appear to be the most inaccurate ones.

5. Empirical analysis

5.1 Panel Estimation

As a mechanism of the preventive arm of the EU surveillance framework, the EC releases spring and autumn forecasts. For the purpose of our work, it was performed an unbalanced panel data, using the earlier described variables, from 1999 to 2012, for the EU-15 (Austria, Belgium, Germany, Denmark, Spain, Finland, France, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Sweden and United Kingdom).

The starting point for the analysis of each year can be represented by the following equation:

$$(2)\ Revenue\ error_{i;t} = \beta_0 + \beta_1.Yield_{i;t} + \beta_2.Net\ L\&B\ (-2)_t + \beta_3.Output\ gap\ (-2)_t + \beta_4.FRI\ (-2)_t + \beta_5.GDP\ error_{i;t} + \beta_6.INF\ error_{i;t} + \beta_7.Coalition_t + \beta_8.Single\ Party\ Gov\ Min_t + \beta_9.Election\ year_t + \beta_{10}.Inc\ change_t + \beta_{11}.VAT\ change_t + \beta_{12}.Corp\ change_t + \beta_{13}Soc.Sec\ change_t$$

where *i* represents the year-semester of the forecast and *t* represents the year for which the forecast refers.

For each one of the forecasting horizons' a baseline model is used, allowing us to have comparisons between those years. Additional estimations are performed, depending on which of the tax change dummies is significant. Seeking a fine-tuning, this should allow us to conclude more precisely which effect is more likely to influence revenue performance. Regarding robustness, in order to make sure that our baseline was the most adequate, we also tried different lags and removed variables that decreased the number of observations.

Following (Afonso & Nunes, 2013), due to possible correlation between DEBT and BAL, it was decided not to include both variables at the same time on our model. Nonetheless, both equations were tested, and the results were very similar. For this reason, and knowing that r-square for BAL was slightly higher the remaining work was done using this variable.

All the equations were made using country fixed effects, which creates a dummy that will account for all the omitted variables for that country. Moreover, all the equations use white diagonal covariance matrix, which consent residual heteroscedasticity (Afonso & Nunes, 2013).

Suspecting the possible existence of endogeneity between $revenue\ error_{i;t}$ and $GDP\ error_{i;t}$, Wu-Hausman endogeneity test was performed. In order to run this test, one should start by regressing the suspecting problematic variable on its instruments – in this case the ones used were VIX(-1) and $GDP\ error_{i;t}$ (-1) – and save the residual series. Then, we include residual series at the baseline, creating an augmented model. If the p-value of coefficient of the residual series is higher than 0.10 we can reject endogeneity. In this case, we did not found evidence of endogeneity evidence in any regression. The following tables represent our results.

Table V – Total revenue error estimation, for year *t*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	-0.326	-0.53	-0.418*	-0.31	-0.217	-0.244	-0.324	-0.287
	(0.269)	(0.448)	(0.239)	(0.244)	(0.266)	(0.27)	(0.268)	(0,267)
Yield	0.07**	0.062*	0.071**	0.077	0.073**	0.071**	0.07**	
	(0.035)	(0.036)	(0.035)	(0.032)	(0.034)	(0.035)	(0.035)	
BAL (-2)	0.027		0.026	0.034*	0.028	0.023	0.028	0.024
	(0.021)		(0.021)	(0.02)	(0.021)	(0.021)	(0.021)	(0,022)
GAP (-2)	-0.021	0.016	-0.017	-0.01	-0.016	-0.013	-0.021	-0.018
	(0.032)	(0.03)	(0.031)	(0.031)	(0.031)	(0.032)	(0.032)	(0,033)
FRI (-2)	-0.106	-0.087			-0.125	-0.1	-0.108	-0.093
	(0.116)	(0.115)			(0.117)	(0.111)	(0.116)	(0,118)
GDP error *t*	-0.071	-0.059	-0.069	-0.066	-0.07	-0.07	-0.071	-0.081
	(0.102)	(0.101)	(0.102)	(0.095)	(0.104)	(0.104)	(0.102)	(0,102)
INF error *t*	0.109	0.138	0.116	0.153	0.136	0.15	0.108	0.133
	(0.116)	(0.114)	(0.115)	(0.11)	(0.113)	(0.117)	(0.116)	(0,117)
Coalition	0.265	0.256	0.278	0.299	0.224	0.227	0.264	0.24
	(0.206)	(0.201)	(0.202)	(0.22)	(0.206)	(0.207)	(0.206)	(0,211)
Minority Gov	0.213	0.216	0.175	0.279	0.156	0.192	0.21	0.2
	(0.255)	(0.26)	(0.248)	(0.253)	(0.255)	(0.25)	(0.256)	(0,264)
Election year	-0.213*	-0.217*	-0.205*	-0.169	-0.185	-0.219*	-0.211*	-0.205*
	(0.122)	(0.122)	(0.12)	(0.119)	(0.123)	(0.125)	(0.125)	(0,124)
Income rate change	0.328***	0.316**	0.33***					0.337***
	(0.125)	(0.125)	(0.125)					(0,127)
VAT rate change	-0.156	-0.225	-0.143		-0.123	-0.109	-0.157	-0.129
	(0.164)	(0.167)	(0.163)		(0.164)	(0.166)	(0.164)	(0,169)
Corp. rate change	0.049	0.066	0.054		0.079	0.085	0.049	0.05
	(0.138)	(0.141)	(0.138)		(0.14)	(0.139)	(0.138)	(0,139)
Soc. Sec. rate change	0.001	-0.008	0.022		0.015	0.025	0	0.023
	(0.157)	(0.157)	(0.154)		(0.159)	(0.158)	(0.157)	(0,155)
DEBT (-2)		0.003						
		(0.006)						
Income up					0.213		0.346**	
					(0.137)		(0.148)	
Income down						0.179	0.313**	
						(0.144)	(0.154)	
Yield (-1)								0.057*
								(0,033)
R-Square	0.169	0.165	0.168	0.139	0.159	0.157	0.17	0.163
Endogeneity	0.7864	0.8830	0.7674	0.7080	0.6740	0.7948	0.7728	0.7602
Cross-sections	15	15	15	15	15	15	15	15
Observations	360	360	360	390	360	360	360	360
Period	2001-2012	2001-2012	2001-2012	2000-2012	2001-2012	2001-2012	200-2012	2001-2012

Notes: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Endogeneity represents the p-value taken from Wu-Hausman endogeneity test for GDP error *t*. Cross-sections is the number of included countries. Period represents covered years.

Table VI - Total revenue error estimation, for year *t+1*

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Constant	0.27	-0.667	0.066	-0.087	0.295	0.258	0.284	0.029
	(0.345)	(0.738)	(0.314)	(0.308)	(0.332)	(0.344)	0.344	(0.388)
Yield	0.136**	0.073	0.131**	0.14***	0.132**	0.137**	0.134**	
	(0.059)	(0.069)	(0.059)	(0.051)	(0.057)	(0.059)	0.059	
BAL (-2)	0.04		0.037	0.035	0.031	0.04	0.039	0.044
	(0.031)		(0.031)	(0.031)	(0.031)	(0.031)	0.031	(0.033)
GAP (-2)	-0.039	0.041	-0.029	-0.05	-0.042	-0.038	-0.04	-0.051
	(0.051)	(0.045)	(0.051)	(0.05)	(0.05)	(0.05)	0.05	(0.053)
FRI (-2)	-0.263	-0.187			-0.273	-0.259	-0.268	-0.234
	(0.229)	(0.232)			(0.225)	(0.228)	0.23	(0.225)
GDP error *t+1*	-0.091**	-0.086**	-0.089*	-0.083*	-0.095**	-0.09**	-0.092**	-0.091**
	(0.046)	(0.044)	(0.046)	(0.046)	(0.045)	(0.045)	0.045	(0.046)
INF error *t+1*	0.428***	0.414***	0.434***	0.381***	0.435***	0.429***	0.427***	0.44***
	(0.087)	(0.086)	(0.086)	(0.09)	(0.087)	(0.088)	0.087	(0.088)
Coalition	-0.268	-0.246	-0.231	-0.158	-0.355	-0.272	-0.275	-0.263
	(0.279)	(0.27)	(0.273)	(0.294)	(0.27)	(0.278)	0.279	(0.279)
Minority Gov	-0.007	-0.046	-0.122	0.073**	-0.035	-0.011	-0.007	-0.005
	(0.391)	(0.382)	(0.374)	(0.417)	(0.401)	(0.391)	0.392	(0.391)
Election year	-0.954***	-0.96***	-0.926***	-0.765***	-0.993***	-0.951***	-0.962***	-0.96***
	(0.166)	(0.167)	(0.165)	(0.19)	(0.167)	(0.167)	0.167	(0.167)
Income rate change	-0.047	-0.057	-0.024		-0.102	-0.055	-0.048	-0.049
	(0.207)	(0.204)	(0.21)		(0.205)	(0.208)	0.207	(0.207)
VAT rate change	0.315	0.2	0.386		0.24	0.316	0.305	0.359
	(0.279)	(0.269)	(0.273)		(0.281)	(0.277)	0.278	(0.278)
Corp. rate change	-0.383*	-0.349*	-0.384*					-0.397*
	(0.206)	(0.206)	(0.207)					(0.205)
Soc. Sec. rate change	0.003	-0.037	0.041		-0.018	-0.01	0.011	0.012
	(0.286)	(0.281)	(0.274)		(0.287)	(0.286)	0.286	(0.285)
DEBT (-2)		0.018						
		(0.012)						
Corp. up					-0.684		-0.756	
					-1042		1041	
Corp. down						-0.351*	-0.362*	
							0.205	
Yield (-1)								0.188**
								(0.077)
R-Square	0.314	0.316	0.311	0.218	0.307	0.312	0.315	0.316
Endogeneity	0.5869	0.7475	0.6596	0.9286	0.6370	0.6206	0.5658	0.8110
Cross-sections	15	15	15	15	15	15	15	15
Observations	330	330	330	360	330	330	330	330
Period	2001-2011	2001-2011	2001-2011	1999-2011	2001-2011	2001-2011	2001-2011	2001-2011

Notes: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Endogeneity represents the p-value taken from Wu-Hausman endogeneity test for GDP error *t+1*. Cross-sections is the number of included countries. Period represents covered years.

Table VII - Total revenue error estimation, for year *t+2* (excluding up and down dummies)

	(1)	(2)	(3)	(4)	(5)
C	0.002	-1.418	-0.161	-0.316	-1.762
	-1008	-1862	(0.881)	(0.774)	(1,889)
Yield	0.238	0.163	0.235	0.194	
	(0.194)	(0.21)	(0.194)	(0.164)	
BAL (-2)	-0.025		-0.03	-0.085	0.027
	(0.082)		(0.08)	(0.073)	(0,026)
GAP (-2)	0.032	0.051	0.039	0.039	0.007
	(0.095)	(0.075)	(0.092)	(0.089)	(0,092)
FRI (-2)	-0.18	-0.081			-0.065
	(0.408)	(0.437)			(0,428)
GDP error *t+2*	-0.06	-0.063	-0.058	-0.068	-0.069
	(0.065)	(0.064)	(0.064)	(0.066)	(0,06)
INF error *t+2*	0.18*	0.168	0.181*	0.165*	0.174
	(0.104)	(0.104)	(0.104)	(0.098)	(0,108)
Coalition	-0.82**	-0.726	-0.778*	-0.557	-0.74
	(0.407)	(0.45)	(0.412)	(0.415)	(0,46)
Minority Gov	-1.173**	-1.169**	-1.257**	-0.969*	-1.213**
	(0.574)	(0.577)	(0.56)	(0.57)	(0,592)
Election year	0.011	0.007	0.034	0.026	0.004
	(0.303)	(0.292)	(0.294)	(0.282)	(0,292)
Income rate change	-0.385	-0.421	-0.36		-0.418
	(0.33)	(0.334)	(0.334)		(0,335)
VAT rate change	0.768*	0.78*	0.815*		0.811*
	(0.436)	(0.426)	(0.43)		(0,44)
Corp. rate change	-0.611**	-0.587*	-0.611**		-0.594*
	(0.308)	(0.316)	(0.308)		(0,314)
Soc. Sec. rate change	0.464	0.478	0.488		0.496
	(0.435)	(0.433)	(0.409)		(0,424)
DEBT (-2)		0.027			
		(0.024)			
Yield (-1)					0.25
					(0,218)
R-Square	0.331	0.337	0.330	0.255	0.341
Cross-sections	15	15	15	15	15
Observations	150	150	150	165	150
Period	2001-2010	2001-2010	2001-2010	2000-2010	2001-2010

Notes: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Endogeneity represents the p-value taken from Wu-Hausman endogeneity test for GDP error *t+2*. Cross-sections is the number of included countries.Period represents covered years.

Table VIII - Total revenue error estimation, for year *t+2* (including up and down dummies)

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
C	0.238	0.023	0.021	-0.027	-0.106	-0.074	-0.055
	(0.972)	-1002	-1006	(0.874)	(0.925)	(0.818)	(0,816)
Yield	0.201	0.232	0.239	0.24	0.283	0.258*	0.259*
	(0.188)	(0.193)	(0.194)	(0.165)	(0.179)	(0.154)	(0,153)
BAL (-2)	-0.057	-0.025	-0.031	-0.025	-0.067	-0.04	-0.047
	(0.086)	(0.082)	(0.083)	(0.079)	(0.075)	(0.076)	(0,077)
GAP (-2)	0.042	0.03	0.038	0.046	0.057	0.059	0.065
	(0.097)	(0.095)	(0.095)	(0.094)	(0.093)	(0.095)	(0,095)
FRI (-2)	-0.196	-0.176	-0.19	-0.029	-0.225	-0.005	-0.015
	(0.412)	(0.408)	(0.41)	(0.412)	(0.398)	(0.414)	(0,416)
GDP error *t+2*	-0.076	-0.061	-0.061	-0.055	-0.044	-0.049	-0.05
	(0.064)	(0.065)	(0.065)	(0.063)	(0.066)	(0.063)	(0,063)
INF error *t+2*	0.178*	0.18*	0.179*	0.186*	0.189	0.191	0.19
	(0.107)	(0.105)	(0.105)	(0.109)	(0.117)	(0.116)	(0,117)
Coalition	-1.065***	-0.844**	-0.836**	-1.024**	-0.841**	-1.085***	-1.102***
	(0.383)	(0.407)	(0.408)	(0.417)	(0.378)	(0.408)	(0,409)
Minority Gov	-1.264**	-1.185**	-1.174**	-1.453**	-1.12**	-1.507**	-1.509**
	(0.578)	(0.575)	(0.575)	(0.599)	(0.541)	(0.607)	(0,607)
Election year	-0.076	0.01	-0.007	0.01	-0.058	-0.015	-0.033
	(0.297)	(0.303)	(0.303)	(0.3)	(0.306)	(0.301)	(0,302)
Income rate change	-0.505	-0.379	-0.422	-0.368	-0.305	-0.334	-0.371
	(0.336)	(0.333)	(0.336)	(0.323)	(0.334)	(0.33)	(0,335)
VAT rate change	0.643	0.768*	0.739*				
	(0.436)	(0.437)	(0.436)				
Corp. rate change				-0.585*	-0.484	-0.532*	
				(0.3)	(0.318)	(0.303)	
Soc. Sec. rate change	0.402	0.459	0.459	0.601	0.455	0.634	0.629
	(0.436)	(0.434)	(0.436)	(0.427)	(0.421)	(0.428)	(0,429)
DEBT (-2)							
Corp. up	-1.806***		-1.886***				-1.837***
	(0.639)		(0.653)				(0,647)
Corp. down		-0.554*	-0.565*				-0.485
		(0.31)	(0.311)				(0,305)
VAT up				1.312***		1.176**	1.148**
				(0.489)		(0.471)	(0,471)
VAT down					-1.5**	-1.028*	-1.062*
					(0.703)	(0.582)	(0,587)
Yield (-1)							
R-Square	0.319	0.327	0.335	0.354	0.333	0.360	0.364
Cross-sections	15	15	15	15	15	15	15
Observations	150	150	150	150	150	150	150
Period	2001-2010	2001-2010	2001-2010	2001-2010	2001-2010	2001-2010	2001-2010

Notes: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Endogeneity represents the p-value taken from Wu-Hausman endogeneity test for GDP error *t+2*. Cross-sections is the number of included countries. Period represents covered years

Table V, represents equations from forecasts made in *t* for *t*. Three variables emerge as the most significant. Income rate changes of 1 p.p. lead to an increase, on average, of 0.328 p.p. of revenue errors. Also, a 1 p.p change on Yield will result in a 0.07 revenue error increase, on average. On the other hand, legislative elections taking place in year *t* have the opposite effect. The existence of an election in year *t* will result in a decrease of revenue error of 0.212 p.p., on average. Knowing that income rate changes lead to higher errors, it was checked whether this errors were caused by an increase or a decrease on personal income tax rates, using equations (5), (6) and (7). None of the effects is significant when tested individually however, equation (7) test for combined effect. The effects are significant at 5 % and both have positive coefficients. Therefore, if the personal income rate changes, the revenue error will be higher, for forecasts made in *t* for *t*.

As regards the estimations reported on Table VI for revenue error estimation made in year *t* for *t+1*, we observe an increase on the number of significant variables, when comparing with the results from table V. As before, the yield is significant and with a similar impact as well as the lagged yield. Election year is again important but now with higher significance. On average, the existence of an election in *t* will result in a decrease of the revenue error of 0.934 p.p. GDP error *t+1* and INF error *t+1* are now significant, which broadly goes into the direction pointed by literature. An increase of 1 p.p. of GDP error for the following year will result on average in -0.9 p.p. on the revenue error whereas INF error for *t+1* will increase the revenue error in 0,424 p.p. Changes to corporate rate are significant in all equations. It seems that, overall, changes to corporate taxes will result in a decrease of the revenue error of 0.378 on average. By controlling for “up” and “down” corporate dummies’, it seems possible to conclude that decreases

in corporate rate taxes in year *t*, decrease the revenue forecast error for the following year.

Table VII present the results for 2-years ahead revenue forecasts. In this case Yield is not significant anymore but inflation errors, for *t+2*, remain significant and account to the increase of revenue errors. In what concerns political variables, in the presence of a coalition there is a decrease in revenue errors of about 0.799 p.p. and minority government also decrease errors in 1.156, on average. In this horizon, two tax changes reveals significant. VAT changes contribute to an increase of revenue errors while corporate tax rate changes drive revenue error decreases'.

Analyzing Table VIII allow us to take a better view at the effects of those rate changes. Estimated individually, all the effects are significant but equation (7) discloses that decreases on the corporate rate are no longer significant. On the other hand, increases on the corporate tax rate reduce the revenue error for *t+2* by 1.837 p.p. This is particularly surprising because there are only two changes on this variable, one for Germany and another for Luxembourg. From (7) we can also observe that only increases to the VAT tax rate implies an increase of revenue errors.

After looking at the results, one can conclude that besides GDP and inflation errors, the other economic variables seem not to be directly connected to revenue forecast errors contrasting with institutional and political variables that emerged as the most significant when comes to explain these same errors.

Another interesting relation is the one between tax changes and their weight for total revenue. Social security contributions are the ones that contribute the most for total revenue in EU-15. However, none of the equations brought significance to social

security rate changes even though there were approximately 70 changes to social security contribution rates, across countries.

Matching the results from Tables V, VI and VII with the Table IV – concerning the descriptive statistic of revenue errors – we observe that *t+1* had the higher mean error and it is for *t+1* estimations where one can find more statistically significant variables. On the contrary, the mean error for *t* and *t+2* was lower, and we also found less significant variables on those equations.

Since it was not found endogeneity evidence, instrumental variables (IV) estimations were not introduced here. Still, for robustness purposes, they were performed for all t and *t+1* equations. The results can be found on the appendix (A.2 and A.3) and confirm that using the least squares provides, for this specific case, the most efficient results.

5.2 SUR system

In order to complete our analysis, we have run a SUR analysis for year *t* and *t+1*. Because of the reduced number of observations it was not possible to estimate the model for year *t+2.* The reason for using this approach is that regardless the previous results, there are cross country differences that cannot be unveiled with simple panel data. Not all countries are influenced by the same variables and with the same intensity.

The SUR model works by running an estimation for each country but at the same time allows for contemporary correlation between residuals of all equations which is more efficient then performing an OLS for each country (Afonso & Nunes, 2013).

For this model, the following equation was used:

$$(3)\ Revenue\ error_{i;t} = \beta_0 + \beta_1.Yield_{i;t} + \beta_2.Net\ L\&B\ (-2)_t + \beta_3.Outputg\ Gap\ (-2)_{i;t} + \beta_4.GDP\ error_{i;t} + \beta_5.INF\ error_{i;t}$$

where *i* denotes the country and *t* the year forecasted.

The reason for using a reduced form of the baseline model is that SUR does not support the use of dummy variables. Moreover, it is also not possible to use FRI since its values are close to a constant over time. In addition, another SUR was performed excluding lagged output gap and can be found on appendix (A.4 and A.5).

Table IX - SUR system *per* country, for total revenue error as a percentage of GDP, for year *t*

Country	Constant	Yield	BAL (-2)	GAP (-2)	GDP error *t*	INF error *t*	R^2	Obs.
AT	-0.585	0.193*	-0.013	0.085	0.235	0.327**	0.221	26
	(0.516)	(0.114)	(0.065)	(0.079)	(0.184)	(0.158)		
BE	-0.302	0.251	0.062	-0.158	-0.023	-0.785***	0.019	26
	(0.814)	(0.187)	(0.09)	(0.144)	(0.205)	(0.298)		
DE	0.542*	-0.079	0.066	-0.072	0.14	-0.329	0.124	26
	(0.316)	(0.083)	(0.049)	(0.06)	(0.122)	(0.24)		
DK	-1.292	0.52**	0.218	-0.479**	-0.518**	-0.226	0.184	26
	(0.995)	(0.226)	(0.17)	(0.213)	(0.208)	(0.444)		
ES	-0.232	-0.023	-0.007	0.063***	1.903	-0.286	0.395	26
	(0.829)	(0.182)	(0.071)	(0.131)	(0.352)	(0.274)		
FI	-0.926*	0.557***	-0.361***	0.31***	-0.172**	0.165	0.433	26
	(0.561)	(0.15)	(0.054)	(0.056)	(0.074)	(0.171)		
FR	-0.534	0.314*	0.1	-0.327***	-0.085	-0.607**	0.259	26
	(0.962)	(0.162)	(0.124)	(0.122)	(0.146)	(0.303)		
GR	0.229	0.085	0.168**	-0.022	0.066	1.057**	0.304	26
	(0.679)	(0.069)	(0.077)	(0.107)	(0.287)	(0.45)		
IE	0.911	-0.066	0.069	-0.271**	0.14	0.247	0.119	26
	(0.901)	(0.206)	(0.058)	(0.133)	(0.121)	(0.24)		
IT	-1.111	0.021	-0.295**	0.198**	0.207	-0.254	0.159	26
	(0.93)	(0.14)	(0.123)	(0.085)	(0.216)	(0.272)		
LU	0.603	-0.447**	0.781***	-0.246*	-0.323***	0.487*	0.583	26
	(0.646)	(0.193)	(0.136)	(0.132)	(0.107)	(0.293)		
NL	-2.652***	0.588***	-0.191**	-0.017	-0.243	-0.864***	0.096	26
	(0.826)	(0.187)	(0.088)	(0.103)	(0.15)	(0.229)		
PT	-0.724	0.036	-0.03	-0.081	-0.176	0.531	0.121	26
	(0.497)	(0.075)	(0.098)	(0.115)	(0.252)	(0.329)		
SE	-1.178**	0.382***	0.061	-0.247***	-0.775***	0.224	0.247	26
	(0.552)	(0.132)	(0.09)	(0.088)	(0.131)	(0.256)		
UK	0.411	-0.151	-0.058	0.09	-0.806***	-0.336*	0.266	26
	(0.854)	(0.176)	(0.052)	(0.093)	(0.251)	(0.199)		

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parenthesis stand for the standard errors. Obs. represent the number of observations for the specific country

Table X - SUR system *per* country, for total revenue error as a percentage of GDP, for year *t+1*

Country	Constant	Yield	BAL (-2)	GAP (-2)	GDP error *t+1*	INF error *t+1*	R^2	Obs.
AT	-1.292	0.161	-0.404***	0.486***	-0.076	0.824***	0.448	26
	-1.095	(0.257)	(0.089)	(0.125)	(0.105)	(0.184)		
BE	-2.928**	0.951***	-0.083	-0.216	0.261*	-0.164	0.056	26
	-1.449	(0.364)	(0.118)	(0.194)	(0.149)	(0.191)		
DE	3.082***	-0.69***	0.152**	-0.335***	-0.216**	0.07	0.494	26
	(0.699)	(0.175)	(0.065)	(0.08)	(0.084)	(0.188)		
DK	0.435	0.207	-0.031	-0.138	-0.403***	0.4	0.208	26
	-1.318	(0.302)	(0.186)	(0.24)	(0.125)	(0.322)		
ES	-3.997***	1.094***	0.275***	-0.376**	1.069***	-0.23	0.562	26
	-1.162	(0.277)	(0.093)	(0.175)	(0.137)	(0.168)		
FI	-1.22	0.71***	-0.283***	0.26***	-0.013	0.054	0.434	26
	(0.786)	(0.21)	(0.079)	(0.076)	(0.051)	(0.151)		
FR	2.069	0.057	0.335	-0.674**	0.158	-0.113	0.468	26
	-2.507	(0.373)	(0.287)	(0.266)	(0.131)	(0.224)		
GR	-1.066	0.389***	0.307**	0.007	-0.116	1.041***	0.331	26
	-1.133	(0.132)	(0.143)	(0.248)	(0.167)	(0.283)		
IE	3.169***	-0.397**	0.035	-0.39***	0.33***	-0.108	0.739	26
	(0.782)	(0.179)	(0.05)	(0.114)	(0.059)	(0.094)		
IT	-1.922*	0.149	-0.471***	0.245***	0.029	0.008	0.205	26
	(0.938)	(0.163)	(0.121)	(0.086)	(0.082)	(0.138)		
LU	-0.102	-0.623**	0.659***	0.056	-0.776***	1.644***	0.796	26
	(0.894)	(0.252)	(0.158)	(0.152)	(0.085)	(0.183)		
NL	-2.943***	0.76***	-0.189**	0.396***	0.243***	0.291***	0.642	26
	(0.894)	(0.215)	(0.095)	(0.097)	(0.081)	(0.112)		
PT	-0.69	-0.731***	-0.803***	0.342***	0.076	-0.044	0.499	26
	(0.425)	(0.084)	(0.089)	(0.105)	(0.104)	(0.107)		
SE	-1.71*	0.443**	-0.022	-0.038	-0.137	-0.075	0.241	26
	(0.892)	(0.204)	(0.156)	(0.119)	(0.087)	(0.381)		
UK	0.082	-0.096	-0.102	0.055	0.126	0.248	0.164	26
	-1.454	(0.297)	(0.095)	(0.139)	(0.141)	(0.207)		

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parenthesis stand for the standard errors. Obs. represent the number of observations for the specific country

Observing Table IX, the results are slightly different from previous equations. It may be noted that there are more significant negative coefficients, than negative. GAP is the variable with more statistically significant frequency contrasting with the constant term. For Denmark, France, Ireland, Luxembourg and Sweden, as GAP increases, the revenue error seems to be reduced, whereas for Spain, Finland and Italy the tendency is to

increase. Surprisingly, Portugal does not have a single significant variable. Inflation errors affect roughly half of the countries. Another result is that, significant GDP errors only contribute to the reduction of the revenue errors. Observing some country facts, GDP and INF are only simultaneously significant for United Kingdom and Luxembourg. . For Germany, only the constant is significant and at 10%. Finland and Luxembourg are the countries with more significant variables.

As it would be expected, table X has more significant values then the previous one. Also, on contrary of table IX here there are more positive significant coefficients making the revenue error increase. Netherlands is now the country with more statistically significant variables followed now by Luxembourg, Spain and Germany. Significant inflation errors coefficients only display positive signs, resulting in an increase of the revenue error when inflation errors increase as well. For *t+1*, Portugal has now Yield, BAL and GAP as significant variables. An increase in the first two decreases revenue forecast errors whereas GAP increases errors. Generally, one can conclude that the variables affect countries in different ways. Despite that, it is not possible to conclude which coefficients have higher impact on revenue errors, if the positive or the negative ones.

6. Conclusions

Having in mind that forecasting is a complex task surrounded by huge uncertainty, the goal of this dissertation was to find the possible determinants of revenue forecasting errors. In order to achieve that, EC bi-annual forecasts were made for the period 1999-2012. Using this data could be risky since EC data was reported by the literature as one of the most accurate among international organizations (Leal et al., 2008). Nevertheless, it was shown that there are in fact some deviations.

The results allowed us to confirm what the literature had already documented, that is, the existence of different sources for revenue errors, namely, economic, political and technical. A particular important result obtained was that tax rate changes do affect revenue errors and that different tax changes affect differently the revenue errors. If, on the one hand, personal income rate changes increase revenue error, for forecasts made in *t* for *t*, increases in corporate tax rate results in a decrease of the revenue errors, in *t+1* and *t+2*. We also confirmed that an increase on GDP error decreases revenue errors, whereas an increase in inflation error will increase revenue errors.

GDP errors, minority governments, election year and corporate rate changes can be associated to overly optimistic revenue forecasts, since they have negative coefficient they would make the error value negative. On the other hand, Yield, inflation errors and VAT changes are associated with a more prudential behavior.

In sum, it is possible to conclude that revenue is affected by political and economical variables and that revenue error determinants' will dependent both on the country and time of forecasting.

References

Afonso, A., & Nunes, A. S. (2013). Economic forecasts and sovereign yields: Department of Economics at the School of Economics and Management (ISEG), Technical University of Lisbon.

Afonso, A., & Silva, J. (2012). The Fiscal Forecasting Track Record of the European Commission and Portugal: Department of Economics at the School of Economics and Management (ISEG), Technical University of Lisbon.

Armingeon, K., Weisstanner, D., Engler, S., Potolidis, P., & Gerber, M. (2012). *Comparative Political Data Set I 1960-2010. Bern: Institute of Political Science, University of Bern.*

Auerbach, A. J. (1995). Tax Projections and the Budget: Lessons from the 1980's. *American Economic Review, 85*(2), 165-169.

Auerbach, A. J. (1999). On the Performance and Use of Government Revenue Forecasts: Berkeley Olin Program in Law & Economics.

Becker, I., & Buettner, T. (2007). *Are German Tax-Revenue Forecasts Flawed?* Ifo Institute and Munich University.

Breuer, C. (2013). *On the Uncertainty of Tax Revenue Projections: A Forecast Error Decomposition for New German Data*. Leibnutz Institute for Economic Research at the Universiy of Munich. Munich.

Brück, T., & Stephan, A. (2006). Do Eurozone Countries Cheat with their Budget Deficit Forecasts? *Kyklos, 59*(1), 3-15.

Buettner, T., & Kauder, B. (2010). Revenue Forecasting Practices: Differences across Countries and Consequences for Forecasting Performance. *Fiscal Studies, 31*(3), 313-340.

Castro, F. d., Pérez, J. J., & Rodríguez-Vives, M. (2011). Fiscal data revisions in Europe: European Central Bank.

Cimadomo, J. (2011). Real-time data and fiscal policy analysis: a survey of the literature: European Central Bank.

Esteves, P. S., & Braz, C. R. (2013). Previsão de curto prazo das receitas dos impotos indiretos: uma aplicação para Portugal. from Banco de Portugal - Working Pape

European Commission. (2013). VAT Rates Applied in the Member States of the European Union: European Commission.

Golosov, M., & King, J. R. (2002). Tax Revenue Forecasts in IMF-Supported Programs: International Monetary Fund.

Hagen, J. V. (2010). Sticking to fiscal plans: the role of institutions. *Public Choice, 144*(3), 487-503.

Leal, T., Pérez, J. J., Tujula, M., & Vidal, J.-P. (2008). Fiscal Forecasting: Lessons from the Literature and Challenges. *Fiscal Studies, 29*(3), 347-386.

Pina, Á. M., & Venes, N. M. (2011). The political economy of EDP fiscal forecasts: An empirical assessment. *European Journal of Political Economy, 27*(3), 534-546.

Tribunal de Contas. (2013). Acompanhamento da Execução Orçamental da Administração Central 2012: Tribunal de Contas.

Appendix

A.1 – Revenue forecast absolute mean for *t, t+1* and *t+2*, by country

Country	3 years absolute mean	Signal
DK	1.388	+
FI	1.093	+
BE	0.718	+
ES	0.608	-
IE	0.532	+
AT	0.483	+
PT	0.422	-
GR	0.362	-
IT	0.326	+
DE	0.290	+
FR	0.207	+
SE	0.192	+
EU-15	0.142	+
NL	0.078	+
LU	0.068	-
UK	0.047	+

A.2 – Total revenue error estimation for year *t*

(Instrumental variables)

	(1)
Constant	-0.284
	(0.364)
Yield	0.063
	(0.052)
Net L&B (-2)	0.03
	(0.024)
Output gap (-2)	-0.031
	(0.,06)
FRI (-2)	-0.113
	(0.124)
GDP error *t*	-0.142
	(0.383)
INF error *t*	0.103
	(0.127)
Coalition	0.256
	(0.213)
Sing Party Min Gov	0.218
	(0.254)
Election year	-0.197
	(0.147)
Income rate change	0.329***
	(0.126)
VAT rate change	-0.188
	(0.242)
Corp.rate change	0.045
	(0.137)
Soc. Sec. rate change	-0.006
	(0.161)
R-Square	0.167
IV	GDP Error *t* (-1) and VIX(-1)
Cross-sections	15
Observations	360
Period	2001-2012

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Cross-sections is the number of included countries. Period represents covered years

A.3 – Total revenue error estimation for year *t+1*

(Instrumental variables)

	(1)
Constant	0.325
	(0.35)
Yield	0.122
	(0.067)
Net L&B (-2)	0.043
	(0.031)
Output gap (-2)	-0.051
	(0.058)
FRI (-2)	-0.27
	(0.229)
GDP error *t+1*	-0.134
	(0.114)
INF error *t+1*	0.453***
	(0.11)
Coalition	-0.291
	(0.281)
Sing Party Min Gov	-0.004
	(0.397)
Election year	-0.966***
	(0.169)
Income rate change	-0.061
	(0.209)
VAT rate change	0.293
	(0.297)
Corp. rate change	-0.377*
	(0.207)
Soc. Sec. rate change	0.024
	(0.294)
R-Square	0.312
IV	GDP Error *t+1* (-1) and VIX(-1)
Cross-sections	15
Obsevations	330
Period	2001-2011

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Cross-sections is the number of included countries. Period represents covered years

A.4 - SUR system *per* country, for total revenue error as a percentage of GDP, for year *t*

Country	Constant	Yield	Net L&B (-2)	GDP error *t*	INF error *t*	R^2	Obs.
AT	-0.397	0.181*	0.052	0.283	0.284*	0.143	26
	(0.497)	(0.105)	(0.06)	(0.178)	(0.163)		
BE	0.012	0.102	-0.019	-0.038	-0.167	0.02	26
	(0.828)	(0.189)	(0.076)	(0.215)	(0.315)		
DE	0.534*	-0.1	0.028	0.224*	-0.467*	0.101	26
	(0.31)	(0.08)	(0.037)	(0.123)	(0.238)		
DK	0.695	0.112	-0.134**	-0.268	-0.491	0.15	26
	(0.622)	(0.159)	(0.065)	(0.214)	(0.468)		
ES	-0.232	0.002	0.037	1.755***	-0.209	0.394	26
	(0.826)	(0.188)	(0.036)	(0.358)	(0.276)		
FI	-1.213*	0.475**	-0.079	-0.254***	0.245	0.243	26
	(0.668)	(0.189)	(0.058)	(0.098)	(0.302)		
FR	-1.751**	0.29*	-0.186***	0.074	-0.159	0.107	26
	(0.791)	(0.149)	(0.069)	(0.145)	(0.298)		
GR	0.154	0.083*	0.157**	-0.135	0.825*	0.278	26
	(0.618)	(0.049)	(0.077)	(0.291)	(0.475)		
IE	1.092	-0.206	-0.015	0.228*	0.089	0.107	26
	(0.868)	(0.183)	(0.038)	(0.116)	(0.23)		
IT	0.53	-0.099	0.009	0.107	-0.049	0.052	26
	(0.795)	(0.141)	(0.096)	(0.225)	(0.288)		
LU	0.853	-0.446**	0.549***	-0.309***	0.18	0.559	26
	(0.678)	(0.203)	(0.086)	(0.118)	(0.286)		
NL	-2.232***	0.497***	-0.171**	-0.195	-0.685***	0.115	26
	(0.817)	(0.183)	(0.077)	(0.142)	(0.225)		
PT	-0.824*	0.05	-0.034	-0.22	0.364	0.105	26
	(0.472)	(0.066)	(0.084)	(0.242)	(0.305)		
SE	-0.925*	0.375***	-0.181**	-0.535***	-0.059	0.218	26
	(0.532)	(0.128)	(0.088)	(0.143)	(0.313)		
UK	-0.086	-0.031	-0.065	-0.789***	-0.47**	0.289	26
	(0.819)	(0.162)	(0.05)	(0.25)	(0.19)		

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Obs. represent the number of observations for the specific country

A.5 - SUR system *per* country, for total revenue error as a percentage of GDP, for year *t+1*

Country	Constant	Yield	Net L&B (-2)	GDP error *t*	INF error *t*	R^2	Obs.
AT	-2.648**	0.632**	-0.198**	-0.111	0.311	0.288	24
	(1.17)	(0.262)	(0.091)	(0.112)	(0.191)		
BE	-1.965	0.624**	-0.196**	0.11	-0.019	0.044	24
	-1.326	(0.315)	(0.087)	(0.133)	(0.153)		
DE	2.902***	-0.773***	-0.087	-0.221**	0.27	0.292	24
	(0.828)	(0.205)	(0.073)	(0.099)	(0.252)		
DK	0.762	0.148	-0.171***	-0.432***	0.596**	0.206	24
	(0.887)	(0.214)	(0.065)	(0.109)	(0.273)		
ES	-3.778***	0.909***	0.047	1.042***	-0.303*	0.539	24
	-1.221	(0.29)	(0.045)	(0.133)	(0.178)		
FI	-1.57*	0.649***	-0.041	-0.065	0.017	0.306	24
	(0.801)	(0.221)	(0.06)	(0.047)	(0.178)		
FR	-4.304***	0.777***	-0.412***	0.183	0.197	0.32	24
	-1.439	(0.289)	(0.106)	(0.115)	(0.195)		
GR	-0.731	0.403***	0.331***	0.032	1.011***	0.325	24
	(0.936)	(0.073)	(0.123)	(0.132)	(0.258)		
IE	4.428***	-0.789***	-0.126***	0.356***	0.032	0.65	24
	(0.79)	(0.165)	(0.034)	(0.063)	(0.091)		
IT	0.349	-0.059	-0.131	0.018	-0.099	0.142	24
	(0.967)	(0.188)	(0.104)	(0.092)	(0.164)		
LU	0.109	-0.756***	0.855***	-0.742***	1.672***	0.793	24
	(0.95)	(0.272)	(0.101)	(0.087)	(0.184)		
NL	-1.342	0.38	0.146*	-0.014	0.421***	0.527	24
	-1.075	(0.259)	(0.076)	(0.087)	(0.133)		
PT	-0.225	-0.568***	-0.541***	-0.003	0.052	0.442	24
	(0.43)	(0.07)	(0.072)	(0.096)	(0.1)		
SE	-1.636	0.437**	-0.099	-0.196**	-0.099	0.242	24
	(0.784)	(0.182)	(0.106)	(0.077)	(0.327)		
UK	-1.702	0.271	-0.168**	0.111	0.225	0.159	24
	-1.358	(0.279)	(0.077)	(0.127)	(0.191)		

Note: Coefficients are significant at 10% (*), 5% (**) and 1% (***). Values between parentheses stand for the standard errors. Obs. represent the number of observations for the specific country

Meta-information

The goal of the following section is describe with detail all the variables used.

Coalition

Description: dummy variable that assumes value 1 if the country government is composed of more than one party in year *t* and 0 for other cases. It includes both surplus and minority coalitions.

Data source: Comparative Political Data Set I (1999-2011) & http://www.parlgov.org/ (2012).

Corporate rate change

Description: dummy variable that assumes value 1 if a change in corporate rate occurred in year *t* and 0 for other cases. Note that, in this case it is considered the current rate, which may include temporary surtaxes.

Data source: computed based on OECD Tax Database.

Corporate rate down

Description: dummy variable that assumes value 1 if a decrease in corporate rate occurred in year *t* and 0 for other cases. Note that, in this case it is considered the current rate, which may include temporary surtaxes.

Data source: computed based on OECD Tax Database.

Corporate rate up

Description: dummy variable that assumes value 1 if an increase in corporate rate occurred in year *t* and 0 for other cases. Note that, in this case it is considered the current rate, which may include temporary surtaxes.

Data source: computed based on OECD Tax Database.

Election year

Description: dummy variable that assumes value 1 if there is an legislative election in in year *t* and 0 for other cases.

Data source: Comparative Political Data Set I (1999-2011) & http://www.parlgov.org/ (2012).

Fiscal Rule Index

Description: based on an EC in questionnaire it is a database on numerical fiscal rules.

Data source: EC (1990-2011).

General government net lending or net borrowing

Description: describes general government's budgetary deficit or surplus.

Data source: AMECO (1999-2012).

General government total revenue error

Description: revenue error for period *t* is the result of the difference between the first total government revenue, as a percentage of GDP, estimate released by the EC in *t+1* Spring, for year t, and the forecasted total revenue for period *t*.

Data source: European Commission (Autumn 1999 - Spring 2013).

Gross domestic product error

Description: GDP error for period *t* is the result of the difference between the first GDP growth rate, in volume and as a percentage change from previous year, estimate released by the EC in *t+1* Spring, for year *t*, and the forecasted GDP growth rate for period *t.*

Data source: European Commission (Autumn 1999 - Spring 2013).

Inflation error

Description: inflation error for period *t* is the result of the difference between the first price deflator of private consumption, as a percentage change from previous year, estimate released by the European Commission in *t+1* Spring for year *t* and the forecasted price deflator of private consumption for period t.

Data source: European Commission (Autumn 1999 - Spring 2013).

Output gap

Description: refers to the gap between actual and potential gross domestic product, at 2005 market prices.

Data source: AMECO (1999-2012).

Personal income rate change

Description: dummy variable that assumes value 1 if a change in (at least) one personal income rate occurred in year *t* and 0 for other cases. Note that, for this case there are different threshold levels with different taxations.

Data source: computed based on OECD Tax Database.

Personal income rate down

Description: dummy variable that assumes value 1 if a decrease in personal income rate occurred in year *t* and 0 for other cases. Note that, for this case there are different threshold levels with different taxations. If for a given year, more than one threshold change, a mean for all the thresholds is computed; if the mean decreases, it is considered that a decrease in personal income rate as occur, and so the variable assumes the value 1. Also, the creation of a lower personal income rate is also considered a decrease.

Data source: computed based on OECD Tax Database.

Personal income rate up

Description: dummy variable that assumes value 1 if an increase in personal income rate occurred in year *t* and 0 for other cases. Note that, for this case there are different threshold levels with different taxations. If for a given year, more than one threshold change, a mean for all the thresholds is computed; if the mean increases, it is considered that an increase in personal income rate as occur, and so the variable assumes the value 1. Also, the creation of a higher personal income rate is also considered an increase.

Data source: computed based on OECD Tax Database.

Public Debt

Description: this variable represents the general government consolidated gross debt, taken from EDP, and therefore based on ESA 1995, as percentage of GDP at market prices.

Data source: AMECO (1999-2012).

Single party minority government

Description: dummy variable that assumes value 1 if the party in government does not own a majority in parliament in year *t* and 0 for other cases.

Data source: Comparative Political Data Set I (1999-2011) & http://www.parlgov.org/ (2012).

Social Security rate change

Description: dummy variable that assumes value 1 if a change in social security rate occurred in year *t* and 0 for other cases.

Data source: computed based on OECD Tax Database.

Social Security rate down

Description: dummy variable that assumes value 1 if a decrease in social security rate occurred in year *t* and 0 for other cases.

Data source: computed based on OECD Tax Database.

Social Security rate up

Description: dummy variable that assumes value 1 if an increase in social security rate occurred in year *t* and 0 for other cases.

Data source: computed based on OECD Tax Database.

VAT rate change

Description: dummy variable that assumes value 1 if a change in VAT rates occurred in year *t* and 0 for other cases. Note that, for this case there are different kinds of tax levels: reduced, standard, increased and parking rates. If for a given year, more than one tax change, a mean for this four rates is computed; if the mean increases, the variable assumes value 1.

Data source: computed based on OECD Tax Database.

VAR rate down

Description: dummy variable that assumes value 1 if a decrease in VAT rates occurred in year *t* and 0 for other cases. Note that, for this case there are different kinds of tax levels: reduced, standard, increased and parking rates. If for a given year, more than one tax change, a mean for this four rates is computed; if the mean decreases, it is considered that a decrease in VAT rate as occur, and so the variable assumes the value 1. Also, the creation of a lower VAT rate is also considered a decrease.

Data source: Computed based on OECD Tax Database.

VAT rate up

Description: dummy variable that assumes value 1 if an increase in VAT rates occurred in year *t* and 0 for other cases. Note that, for this case there are different kinds of tax levels: reduced, standard, increased and parking rates. If for a given year, more than one tax change, a mean for this four rates is computed; if the mean increases, it is considered that an increase in VAT rate as occur, and so the variable assumes the value 1. Also, the creation of a higher VAT rate is also considered an increase.

Data source: computed based on OECD Tax Database.

VIX

Description: Standard and Poor's 500 volatility index, taken from June and December of each year.

Data source: Yahoo finance (1999-2011).

Yield

Description: this variable follows the European Monetary Union (EMU) convergence criterion bond yields. For the purpose of this work, bi-annual data was taken, from June and December of each year. By doing this, it is expected to reflect all the available information known by the forecaster at the time.

Data source: Eurostat (June 1999 to December 2012).