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Country-specific fiscal reaction functions: what lessons for EMU ?

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Abstract

This paper deals with heterogeneous fiscal behaviors of euro area countries. We estimate EMU Members States fiscal reaction function using time series approach covering the period 1990 :Q1 - 2017 :Q2. Among the major lessons from this analysis, three general and striking results are worth highlighting : (1) factors explaining national fiscal reaction function in the short run differ from those in the long run, (2) some explanatory variables seem common to all countries while others only concern a small number of countries and (3) the sign of the impact of these explanatory variables can also differ between the countries. Finally, this paper raises the implications of heterogeneous fiscal policies on the functioning of monetary union and asks the question of fiscal convergence in the euro area.

Keywords : fiscal reaction functions, euro area, error correction model, heterogeneity

Classification JEL : E 62, H61, H 62, C 33, C 41

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1 Introduction

The euro area's sovereign debt crisis has raised the issue of public finance sustainability and shed light on member states heterogeneous fiscal behavior. To coordinate and regulate the euro area's fiscal policies, fiscal discipline was introduced with the Maastricht Treaty (1992) succeeded by the Stability and Growth Pact (1997), already reformed three times.

In order to understand what are the determinants of national fiscal policies, we must look at "fiscal reaction function" (FRF), (« fiscal stance » is also sometimes used to characterize the budgetary position). In other words, the question asked is : what are the variables that condition the direction of fiscal policy in a country every year ? In general terms, it is a question of identifying the macroeconomic variables to which the fiscal policy of governments is sensitive. In the case of the EMU, this issue is crucial for at least three specific reasons :

- ⋆ Knowing precisely the determinants of national fiscal policies of euro area member states helps to identify common features and main differences in practice, and therefore potential sources of heterogeneity between countries. These heterogeneities may be the cause of asymmetric responses to economic shocks that could destabilize the euro area as a whole.
- ⋆ Identifying these explanatory variables over a long period also makes it possible to measure the impact that the birth of the euro area (and also the budgetary rules that accompanied it) may have had on the trajectory of national public finances.
- ⋆ Better knowledge of national specificities in terms of public finance is an essential step for the next reform of the economic governance of the euro area, which will decide the future of the EMU.

Since the end of the 1990s, with the founding work of Bohn (1995) and Bohn (1998), interest has indeed focused on the factors that explain the evolution of fiscal policy. In the context of the financial and sovereign debt crisis, in order to explain fiscal reactions to some macroeconomic conditions, the literature has substantially grown. For a long time limited to the study of the United States or of all OECD countries, more recent work focuses on the case of the EU in general, and the EMU in particular. Indeed, since the seminal paper of Bohn (1998), the literature generally accepts that a sustanaible fiscal policy satisfying the intertemporal budget constraint displays a positive response of primary balance to changes in public debt. Indeed, applied to U.S. data, Bohn (1998) shows that primary balance is an increasing function of the

public debt ratio. From Bohn (1998), a large part of the literature on fiscal reaction functions agrees with this condition and frequently estimates a positive response of primary balance to change in public debt.[1] In the specific case of the EU, the literature frequently estimates a fiscal reaction function using a panel, given the problem of the size of temporal series. Fewer papers estimate a country-specific fiscal reaction function as Fincke and Greiner (2012), Schoder (2014) or Berti and al. (2016) but all papers only concern a partial selection of countries[2]. In addition, Baldi and Staehr (2016) raised the lack of research studies on the fiscal reaction function for a selection of individual countries.

While few studies focus on each EMU country specifically, this article, which includes the main explanatory variables used in the literature, offers an original contribution in three ways : (i) it is interested in each country of the EMU separately, (ii) it considers national fiscal behavior from 1990 to 2017, (iii) it considers a differentiated impact of these explanatory variables according to the time horizon considered. To do this, two complementary approaches were used : (1) a panel estimation as a preliminary analysis, in order to validate (or not) the relevance of country-specific estimations ; (2) time series estimation achieved by error correction models allows us to highlight long-run fiscal dynamics (by analyzing public debt sustainability) and short-run dynamics (by analyzing determinants of the fiscal policy). Thus, we emphasize fiscal heterogeneities, and raise potential problems for the functioning of the euro area before suggesting some recommendations in the conclusion.

This paper is structured as follows. Section 2 briefly explains what fiscal reaction function is and how its interpretation depends on the indicator used to estimate it, and offers a brief fiscal reaction function literature review on the specific case of the EU. Section 3 presents the descriptive analysis to display the fiscal heterogeneities related to main variables used. Section 4 describes the empirical methodologies used and discusses the main results based on time series estimation with short-run and long-run analysis. Finally, section 5 concludes, raises some policy recommendations and extensions.

1. The literature review in Berti and al. (2016) and Checherita-Westphal and Zdarek (2017) shows many papers estimating a positive reaction of fiscal policy to public debt.

2. For instance, Berti and al. (2016) estimate national fiscal reaction functions to 13 European member states. The results show that the financial crisis has significantly increased the fiscal response to change in public debt. Legrenzi and Milas (2013) estimate a fiscal reaction function for 4 euro area countries : Greece, Ireland, Portugal, Spain (GIPS). Schoder (2014) analyzes the sustainabilty of sovereign debt in 15 OECD countries using the sustainable conditions initiated by Bohn (1998). He finds that the euro convergence criteria contributed to the sustainability of public debt for some euro area countries tested but, for some countries (Greece, Portugal and Spain), he underlines a lack of debt sustainability.

2 What do we know about fiscal reaction functions ?

After defining fiscal reaction function, a brief review of the literature is proposed to highlight the main results already obtained on the determinants of fiscal policy.

2.1 Fiscal reaction functions in a nutshell

To understand the analysis of fiscal policy determinants, it is essential to focus on the different components of the public balance. Indeed, public balance can be broken down into three main elements :

- A discretionary component, resulting from all the deliberate budgetary measures taken by a government at a given time ;
- An automatic component, resulting from the play of automatic fiscal stabilizers : the automatic fiscal stabilization corresponds to the mechanism by which the automatic evolution of budget makes it possible to cushion the effects of cyclical shocks (for instance, a decrease in collected tax revenues and increase in the unemployment benefits paid in case of economic slowdown) ;
- A component related to the burden of public debt.

In other words, public balance B_{it} of a country i at date t could be written as :

$$B_{it} = B_{it}^{D} + B_{it}^{A} + i_{it} D_{it-1} \tag{1}$$

where B_{it}^{D} corresponds to the discretionary balance, B_{it}^{A} the automatic balance and $i_{it} D_{it-1}$ the public debt burden where i_{it} is the nominal interest rate applied to public debt and D_{it-1} is the stock of public debt.

In a general manner, the explained variable generally used for the estimate is the primary public balance or the cyclically corrected primary public balance. In this framework, primary budget balance noted PB_{it} corresponds to the budget balance adjusted for the weight of public debt (i.e. $PB_{it} = B_{it} - i_{it} D_{it-1}$). In other words, the primary balance does not take into account the interest on public debt and includes only discretionary balance and automatic balance. Cyclically-adjusted budget balance (also known as structural budget balance) SB_{it} corresponds to budget balance adjusted for automatic fluctuations from budget to cycle (i.e.

$SPB_{it} = B_{it} - B_{it}^{A}$). It does not take into account the automatic budget balance, and includes only the discretionary balance and the burden of public debt. In this context, cyclically-adjusted primary budget balance noted SPB_{it} only considers discretionary budget balance.

In the study of fiscal reaction functions, considering primary balance does not take into account the weight of public debt interest in the explanatory variables of the fiscal policy (which does not prevent us from considering that the level of public debt conditions fiscal policy, as we will see later). On the contrary, focusing on cyclically-adjusted primary balance only considers discretionary fiscal policy in the assessment of fiscal reaction function. It is on the empirical method used and the nature of the explanatory variables considered that are distinguished the different studies on fiscal reaction functions. these studies provide very mixed and sometimes contradictory results.

2.2 Literature review

A first category of studies deals with the relationship between fiscal policy measured by primary balance (PB_{it}), primary budget balance in previous periods and the level of public debt (more or less delayed) without taking into account other possible explanatory variables. In other words, the aim is to assess the extent to which the level of public debt has an impact on the fiscal policy implemented. As such, Ghosh and al. (2013) or Medeiros (2012) highlight the possibility of government "fiscal fatigue" when public debt remains high for a long time. They try to determine the "fiscal space" to stabilize public debt. Weichenrieder and Zimmer (2015) examine the extent to which entry into the euro area changed governments'behavior towards public debt by distinguishing different regimes (pre-Maastricht, pre-accession period, accession to EMU). It appears that, for a group of three highly indebted countries (France, Greece and Portugal), the strong reactions of primary balance to the evolution of public debt levels before accession to the EMU were not continued after entry into the EMU. On the other hand, there has been no significant reduction in "fiscal prudence" for other countries. In the same vein, Afonso and Jalles (2017) confirm that governments increased primary balance to cope with higher levels of public debt.

Other studies focus on the relationship between fiscal policy and the state of the economy. In other words, these studies focus on the trade-off between economic stabilization and fiscal

consolidation. The question raised is : to what extent does the macroeconomic situation of a country (assessed by the output gap) have an impact on the fiscal policy implemented ?

There are two alternative ways to consider this issue : (1) either taking into account both automatic and discretionary fiscal policy (in this case it is the primary balance that will be considered), (2) or focusing only on the discretionary fiscal policy (in this case it is the cyclically adjusted primary balance that will be considered).

In case (1), Plodt and Reicher (2015) or Baldi and Staehr (2016) show, in particular, that national fiscal policies remain counter-cyclical over the entire period studied. However, the sensitivity of the primary balance to public debt has increased, both for countries in crisis and those less affected. Despite high public deficits and the accumulation of public debt, fiscal reaction function appears more cautious since the bursting of the EMU debt crisis since 2008. In case (2), the focus is only the relationship between discretionary fiscal policy and the state of the economy, focusing on the hypothesis of asymmetry in the cyclical behavior of governments (which would be different depending on whether the cyclical conditions are good or bad). As such, Huart (2011) seeks to determine whether fiscal policies are more counter-cyclical or pro-cyclical since their entry into the EMU. The objective is thus to determine whether the cyclical behavior of discretionary fiscal policies has changed in the euro area countries since 1999, and in particular whether this behavior is asymmetrical according to good or bad economic times. Between 1970 and 2008, it appears that among the 12 countries in the euro area, only Finland and the Netherlands have a significantly counter-cyclical discretionary fiscal policy. After 1999, the fiscal stance is significantly and strongly contra-cyclical in Spain, Ireland and the Netherlands. A notable development is observed in Austria : the discretionary fiscal policy has become significantly pro-cyclical. Plodt and Reicher (2015) and Caprioli and al. (2017) conduct the same kind of analysis but with a different methodology and achieve similar results.

A final series of studies consists in integrating other explanatory variables to assess the determinants of fiscal policy, generally evaluated on the basis of the primary balance, especially : inflation rate in the monetary union, interest rates and also the current trade balance situation. The inflation indicator makes it possible to assess the relationship between fiscal policy and monetary conditions in the monetary union. Interest rates indicator enables us to measure the

financial markets pressure on fiscal policy implemented by a country. Current account balance makes it possible to test, in particular, the hypothesis of twin deficits[3]. For instance, Legrenzi and Milas (2013) focus on the role of interest rates for PIGS (Portugal, Ireland, Greece, Spain). In particular, they show that under financial markets pressure, all countries are lowering their debt ceiling above which measures are taken. As a result, financial markets pressure appears to be more effective than the formal Excessive Deficit Procedure (EDP) in encouraging Member States to correct fiscal imbalances. Berti and al. (2016) and Maltritz and Wuste (2015) introduce the inflation rate and interest rates as explanatory variables for national fiscal policies that ultimately appear insignificant. Checherita-Westphal and Zdarek (2017) focus on the effect of the current account balance on fiscal reaction functions. The positive coefficient of the current balance tends to confirm the twin deficit hypothesis.

3 Descriptive analysis : heterogeneous fiscal behavior in euro area countries

Before estimating national fiscal reaction functions, it is first necessary to underline the evolution of national public finance in the eurozone macroeconomic context. This first analysis enables us to identify key economic variables that can be used later.

3.1 National public finance features

At first glance, national public finance can be analyzed through three major indicators : total public balance, primary public balance and public debt. Table 1 below summarizes the situation for the 19 eurozone Member States between 2007 and 2016. Three main lessons can be drawn from this analysis.

3. "Twin deficits" or "double deficits" refer to the situation of a country simultaneously recording a public deficit and a current account deficit, ie a situation in which government expenditure exceeds their current account deficit, income, and where imports of goods and services are greater than exports.

TABLE 1 – **Overview of national public finance (pre/post crisis)**

Countries	Budget balance ratio to GDP (cyclical component)			Primary budget balance	Public debt ratio to GDP in 2016 (pts variation 2007-2016)	Gap of government spending	Gap of tax revenues
	2007	peak of the crisis	2016	2016		(pts variation 2009-2016)	
Austria (AT)	-1.4 (1.3)	-5.4 (-1.5) (2009)	-1.6 (-0.5)	1.4	84.6 (+19.5)	-3.4	+0.4
Belgium (BE)	0.1 (1.8)	-5.4 (-1) (2009)	-2.6 (-0.4)	0.9	105.9 (+18.2)	-0.2	+2.6
Cyprus (CY)	3.2 (2.6)	-5.4 (-0.2) (2009)	0.4 (-0.4)	5	107.8 (+54.3)	-1.4	+2.8
Estonia (EE)	2.7 (6.4)	-2.7 (-4) (2008)	0.3 (0.1)	0.5	9.5 (+5.8)	-5.7	-3.2
Finland (FI)	5.1 (2.6)	-2.6 (-1.4) (2010)	-1.9 (-1.1)	1.1	63.6 (+29.6)	+1.3	+2
France (FR)	-2.5 (1.8)	-7.2 (-1.3) (2009)	-3.4 (-0.8)	-1	96 (+31.7)	-0.6	+3.2
Germany (DE)	0.2 (1)	-4.2 (-1.1) (2010)	0.8 (-0.1)	2.3	68.3 (+4.6)	-3.3	-1.7
Greece (GR)	-6.7 (3)	-15.1 (-1.6) (2009)	0.7 (-4.7)	6	179 (+75.9)	-5.1	+10.8
Ireland (IE)	0.3 (2.5)	-32.1 (-1) (2010)	-0.6 (1)	-2.3	75.4 (+51.5)	-37.3	-5.8
Italy (IT)	-1.5 (1.3)	-5.3 (-2.1) (2009)	-2.4 (-0.9)	2.1	132.6 (+32.8)	-1.6	+1.2
Latvia (LV)	-0.6 (4)	-9.1 (-4.3) (2009)	0 (0.6)	1.9	40.1 (+31.7)	-7.4	+1.8
Lithuania (LT)	-0.8 (3.7)	-9.1 (-4.3) (2009)	0.3 (0.3)	2	40.2 (+24.3)	-10.7	-1.3
Luxembourg (LU)	4.2 (2.4)	-0.7 (-2.5) (2009)	1.6 (-0.4)	1.9	20 (+12.2)	-3.9	-1.8
Malta (MT)	-2.2 (0.6)	-4.2 (-1) (2008)	1 (0.7)	2.5	58.3(-4.1)	-3.8	+0.5
Netherlands (NL)	0.2 (1.4)	-4.2 (-1.8) (2009)	0.4 (-0.5)	2.4	62.3 (+19.6)	-4.6	+1.3
Portugal (PT)	-3 (0.7)	-11.2 (-1) (2010)	-2 (-0.3)	3	130.4 (+62)	-5.1	+2.7
Slovakia (SK)	-0.8 (2.8)	-9.1 (-0.8) (2009)	0.3 (-0.1)	-0.1	40.2 (+24.3)	-2.5	+3.7
Slovenia (SI)	-0.1 (3.2)	-5.9 (-1.5) (2009)	-1.8 (-0.2)	2.4	79.7 (+56.9)	-0.1	+1.3
Spain (ES)	1.9 (1.6)	-11 (-1.7) (2009)	-4.5 (-1)	-1	99.4 (+63.8)	-3.2	+3.1
Euro area (EA)	**-0.6 (-1.5)**	**-6.3 (-1.9) (2009)**	**-1.9 (-0.6)**	**1.5**	**89.2 (+24.2)**	**-3**	**+1.8**

Source : European Commission, 2017

3.1.1 The impact of the economic crisis on public finance

Only Greece displayed a deficit of more than the 3% of GDP ceiling in 2007, 9 countries even displayed a positive budget balance. Moreover, all countries have a positive cyclical balance. But government budget balances have significantly decreased in 2008-2010 as a result of crisis. Indeed, the euro area public deficit has increased from 0.6 (2007) to 6.3% of GDP (2009). Furthermore, Greece, Ireland, Portugal and Spain have a public deficit more than 10% of GDP. Similarly, euro area public debt raised of 24.2 points between 2007 and 2016. While 10 countries respected the limit to 60% of GDP in 2007 they are only 6 to respect this ceiling in 2016.

3.1.2 An increase in public finance heterogeneities

After the turmoil of the crisis, most countries have reverted their budget balance level. In 2016, only 2 countries, France and Spain, displayed a deficit more than 3% of GDP (respectively 3.4% and 4.5%) and 8 countries have improved their government budget balance compared to 2007 (Germany, Greece, Latvia, Lithuania, Malta, Netherlands, Portugal and Slovakia). To return to their pre-crisis level, countries have been forced to implement a stronger fiscal effort corresponding to the gap of the worst year of the crisis (2008, 2009 or 2010, according to the countries) and 2016. Ireland is a specific case because the financial stress context has strongly

increased the deficit before returning to a normal situation. Excluding Ireland, the fiscal gap between 2009 and 2016 is close to 5 pts of GDP in union-wide terms. But, some crucial disparities emerge. Around 2.5 pts for Belgium, Italy or Estonia, yet more than 15 pts of GDP for Greece. Moreover, when we look at the primary budget balances in 2016, we note that, excluding interest payment on public debt, only 4 countries display a deficit. This observation show the high weight of the public debt burden for euro area countries.

3.1.3 Public finance adjustments implemented

To reduce their government budget deficit since the peak of the crisis, governments must have implemented a drop in public spending and/or an increase in tax revenus. On the spending side, all countries have reduced expenditure except Finland. We could compute an overall decrease of 3 pts of GDP but we observe a high disparity level. From -0.1 (Slovenia) for the smallest decrease in government spending, to -10.7 pts of GDP (Lithuania) if we except the specific case of Ireland previously described. On the tax revenue side, the euro area has increased tax revenues to 1.8 pts of GDP on average since 2009. We also find a disparity because some countries have increased fiscal pressure (Austria, Belgium, Cyprus, Finland, France, Greece, Italy, Latvia, Malta, Netherlands, Portugal, Slovakia, Slovenia and Spain) while the tax revenues have decreased for other countries (Estonia, Germany, Lithuania and Luxembourg). Then, we could distinguish 3 main fiscal strategies to improve the government budget balance since 2009 : (1) countries which have reduced their deficit mainly by a decrease in government spending (Austria, Estonia, Germany, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta and the Netherlands) ; (2) countries which have reduced their deficit mainly by an increase in tax revenues (Belgium, Cyprus, Finland, France, Greece, Slovakia and Slovenia) ; (3) Spain which seems to be a specific case. Indeed, Spain has reduced government spending and simultaneously increased tax revenues (-3.2 and 3.1 pts of GDP respectively).

3.2 Key macroeconomic variables

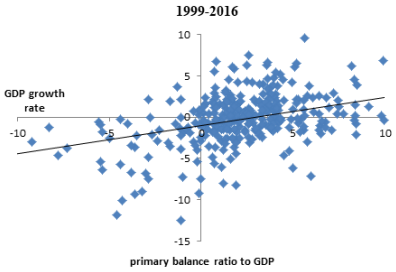
Analyzing national fiscal behaviors requires us to consider the macroeconomic context during the period. We focus on the real GDP growth rate, inflation rate and long-term interest

rate. These crucial variables would be considered as part of the explanatory variables to explain the primary budget balance chosen as the dependent variable in the rest of this study.

3.2.1 Business cycle indicator : real GDP growth rate

The business cycle indicator is considered as an unavoidable variable to explain fiscal reaction function [4]. Even if Fincke and Greiner (2012), pointed out that the business cycle indicator could display a negative sign, the literature overall shows a positive impact of the GDP growth rate (or output gap) on primary balance ratio to GDP. In other words, an increase in the GDP automatically improves the primary balance ratio through an increase in tax revenues and a decrease in public spending. In this view, Wyplosz (2005) for instance, has shown that a positive relationship could also be interpreted as a counter-cyclicality. Indeed, governments improve public finance by a more favorable government budget balance in the case of GDP growth. Scatterplot 1 allows us to agree with the literature about this positive relationship. All points represent for each countries annual GDP growth rate data associated with the primary balance data for the same year. Whatever the selected period, we find a positive relationship even if 2008-2016 is characterized by a stronger disparity for both variables selected. Then, the crisis period seems to increase the disparity across countries.

Scatterplot 1 : Relationship between primary balance ratio to GDP and real GDP growth rate for euro area countries (1999-2016).



Source : Eurostat and DG ECOFIN, Economic Forecast (Spring 2017)

3.2.2 Inflation rate

As Ghosh and al. (2013), Fournier and Fall (2017) and Maltritz and Wuste (2015), we also include the inflation rate as an independent variable. Fournier and Fall (2017) estimate

4. Even if most papers use the output gap, we prefer the real GDP growth rate to be closer to the non-stationary data as Gali and Perotti (2003) or Maltritz and Wuste (2015) . Indeed, the output gap is I(0) while the GDP growth rate could be stationary depending on the time and countries.

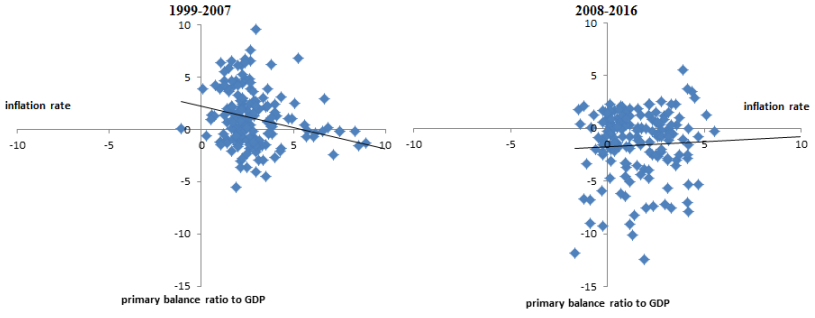
a positive coefficient and find that inflation has a stronger effect on the increase of tax revenues than on the increase in government spending. Contingency table 1 shows all countries (except Malta) displayed an inflation rate higher than 1.5% in 2007, while, in 2016, all countries (except Belgium) displayed an inflation rate lower than 1.5%. Besides, 6 countries are in a deflation process (Cyprus, Ireland, Italy, Slovakia, Slovenia and Spain). Moreover, Scatterplot 2 allows us to see an averse relationship between primary balance and inflation rate according to the period 1999-2007 and 2008-2016. For the period 1999-2007, we simultaneously observe an overall improvment in primary balance and an acceleration of the inflation rate. This improvment could be explained by the implementation and strengthening of fiscal rules on public finance (corresponding to the beginning of the euro area) and the increase in the inflation rate could especially be caused by the increase in commodity prices and energy price. But, over the whole period, we find a slightly positive relationship.

TABLE 2 – **Budget balance in relation to inflation rate for euro area countries (2007 ;2016)**

	2007				2016			
Government budget balance / inflation rate	$< -5\%$ excessive	$[-5\%;-3\%[$ deficit procedure	$[-3\%;0\%[$	$\geq 0\%$	$< -5\%$ excessive	$[-5\%;-3\%[$ deficit procedure	$[-3\%;0\%[$	$\geq 0\%$
$< 0\%$						ES	IE ; IT ; SK ;SI	CY
$[0\%;1,5\%]$			MT			FR	EA. ; AT ; FI. ; PT	EE ; DE ; GR ; LV ; LT ; LU ; MT ; NL
$]1,5\%;2,5\%]$			EA ; AT ; FR ; IT ; PT ; SK	BE ; CY ; FI ; DE NL			BE	
$> 2.5\%$	GRE		LV ; LT ; SI	EE ; IE ; LU ; ES				

Source : Eurostat

Scatterplot 2 : Relationship between primary balance ratio to GDP and inflation rate for euro area countries (1999-2016)



Source : Eurostat

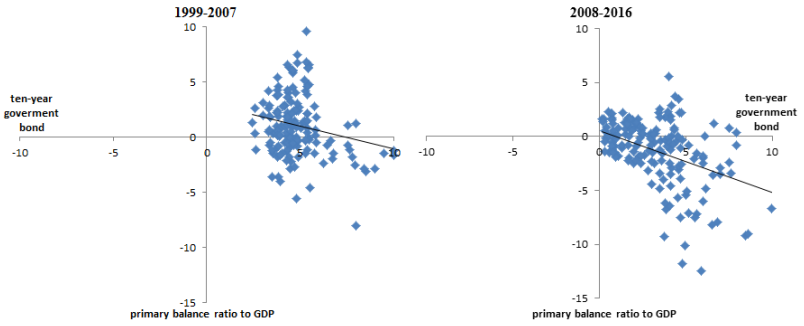
3.2.3 Ten-year government bond : long-term interest rate

We also consider the long-term interest rate represented by ten-year government bonds. As shown by Fincke and Greiner (2012) and Maltritz and Wuste (2015), ten-year government bonds can indirectly affect primary balance because the level of interest payments plays a crucial role in government fiscal decisions. More precisely, a higher ten-year government bond tends to reduce primary balance. But, there is no consensus on the sign of relationship. Maltritz and Wuste (2015) find a non-significant effect, meaning that financial market pressure is not enough to improve the public finance situation, while, Legrenzi and Milas (2013) find that financial pressure positively affects primary balance.

Similarly to economic growth implication, the relationship between primary balance and ten-year government bonds does not seem to change significantly over time. Indeed, Scatterplot 3 displays a negative relationship for both periods. Then, a worst primary balance is related with a high ten-year government bond. This result could theoretically be intuitive because a higher ten-year government bond indicates higher interest payments which deteriorates public finance. Moreover, we observe a clear difference between both periods. Period 2008-2016 is characterized by some annual ten-year government bonds close to 0 for some countries compared to 1999-2007. Moreover, compared with the period 1999-2007, the second period is characterized by a high disparity level. In more detail, Graph 1 below allows us to display the spread of the ten-year government bond related to Germany [5]. We have selected the spread to try to easily distinguish two groups : countries close to Germany's situation and other countries. The first and second groups respectively have several times named the core and peripherical countries of the euro area as Duwicquet and al. (2013) or Baldi and Staehr (2016), who simulate fiscal reaction functions for several group of european countries.

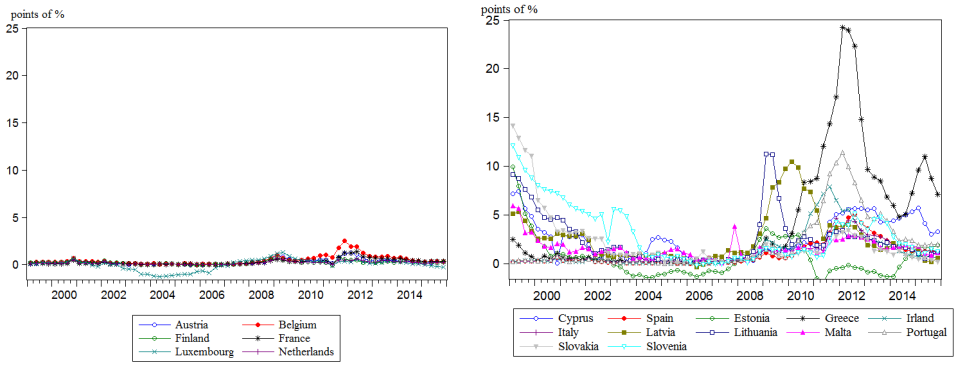
5. We compute the spread from Germany which displays the lower ten-year government bond.

Scatterplot 3 : Relationship between primary balance ratio to GDP and the ten-year government bond for euro area countries (1999-2016)



Source : Eurostat ; ECB via Statistical Data Warehouse

Graph 1 : Spread of the ten-year government bond related to Germany for euro area countries (1999-2016)

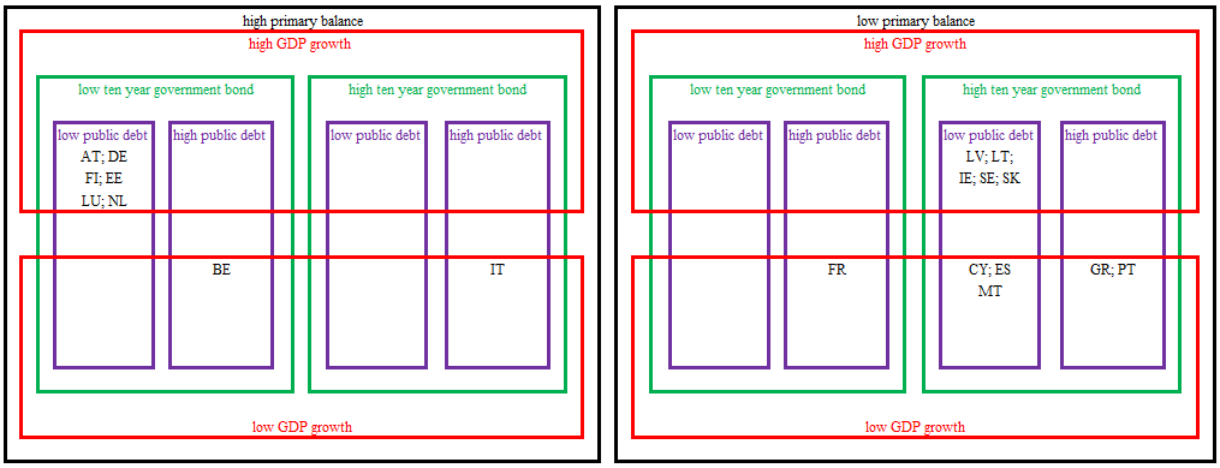


Source : ECB via Statistical Data Warehouse

3.3 Eurozone countries ranking

This preceeding descriptive analysis offer material to propose a ranking of eurozone countries for the 1999-2016 period based on four criteria [6] : (1) primary budget balance level, (2) public debt level, (3) GDP growth level and (4) ten-year government bond level. Figure 1 summarizes all of these features and enables us to distinguish three main groups of countries [7].

Figure 1 : Ranking of Eurozone countries (1999-2016)



Top left, we find Austria, Estonia, Finland, Germany, Luxembourg and the Netherlands in a group which overall displays a better fiscal and economic performance that the euro area average from 1999. Indeed, this group displays a higher primary balance, higher GDP growth rate, lower ten-year government bond and lower public debt ratio than the euro area average. Belgium is close to this group but displays a higher public debt than the euro area. Indeed, Belgium displays an average public debt ratio more than 100% of GDP for the 3 selected periods (respectively, 76.7%, 67.9% and 85.5% for 1999-2016, 1999-2007 and 2008-2016). Following the literature, these countries could be called as "the core countries" even if we can not find a consensus about the countries classified in this group [8].

6. We have not selected an inflation rate corresponding to the ECB target. Indeed, at this stage, we have only considered macroeconomic variables directly related to fiscal policy implication.

7. We have selected fiscal and economic variables explained before to rank the countries and separated each variable in "low level" or "high level" according to the euro area average. For all countries and each variable, we have computed 3 time averages : 1999-2016; 1999-2007; 2008-2016. Next, we compare the time averages with the euro area data series allowing us to say if the countries display a "lower" or "higher" performance than the euro area. For instance, Germany displays for the 3 periods, a lower ten-year government bond than the euro area average. Then, we rank Germany in the low ten-year government bond box. Similarly, Italy displays a lower GDP growth rate than the euro area average for the 3 periods, then, we rank Italy, in the low GDP growth rate box. We repeat the same procedure for each country and each variable.

8. We also find France according to the literature, for instance.

Bottom right, we find an opposite group which overall displays a weaker performance than the euro area average. We could include Greece and Portugal which together display a lower primary balance ratio, lower GDP growth rate, higher ten-year government bond and higher public debt ratio than the euro area. But, we can underline the crisis impact because if we only consider the pre-crisis period (1999-2007), Greece and Portugal displays higher GDP growth rate than the euro area.

Top right, Latvia, Lithuania, Slovakia and Slovenia have similar fiscal and economic features displaying a lower primary balance and public debt ratio than the euro area, but a higher GDP growth rate and ten-year government bond. We also include in this group, Ireland which displays a common feature because of the crisis. Indeed, before 2007, Ireland could be classified in the group of "core countries", but the crisis has strongly raised the ten-year government bond and primary balance, such that the general ranking of Ireland has been changed. Cyprus and Malta display almost the same features as the previous group but, their GDP growth rate is lower than the euro area average. Similarly to Ireland for the previous group analysis, here, Spain is included with Cyprus and Malta because of the crisis period. Before the crisis, Spain displayed higher primary balance and higher GDP growth rate than the euro area. Then, Spain seems to be one of the countries which has been strongly impacted by the crisis.

Finally only two countries appear as special cases : France and Italy. France displays a weaker performance of primary balance ratio, GDP growth rate and public debt than the euro area, but France benefits from a lower ten-year government bond. We could explain this result by the size and status of France in the euro area. Frequently considered by the literature as "Too big to fail". Italy is also a specific country because she displays a higher primary balance, public debt ratio and ten-year government bond but lower GDP growth rate than the euro area average. Then, the public debt and GDP growth rate level could explain the higher ten-year government bond because the financial markets could be cautions about lending.

4 What are the key determinants of national fiscal reaction functions ? Main lessons

After presenting the general methodology and the data used, an initial analysis offers preliminary results from panel data estimation. An analysis based on time series estimations then highlights a number of crucial lessons on the determinants of fiscal reaction functions in EMU.

4.1 General methodology

To assess fiscal reaction functions, literature opposes two main methodologies : panel or time series estimations. Both methods have their pros and cons. Panel data estimations avoid constraint by the short time period, so allows us to use annual macroeconomic data without thinking about the temporal dimension. Time series estimations need to use long-time series. All the more so as some papers bring to light noisy quarterly fiscal data [9], while others maintain that Eurostat, OECD and so on apply a consistent methodology which makes reliable data. Nevertheless, Staehr (2008) and Egert (2014) raised similar results using annual or quarterly data. Besides, as shown in the literature review of Berti and al. (2016), a large part of the literature uses quarterly data even if most estimations are performed by panel. This paper is aware of this methodological debate. To provide a complete analysis, we offer panel and time series estimations.

4.1.1 Selected variables

As detailed in the previous descriptive analysis section, we use primary balance ratio to GDP as dependent variable and public debt ratio to GDP, real GDP growth rate, inflation rate and ten-year government bond as macroeconomic explanatory variables.

We also add other control variables. Firstly, following Berti and al. (2016) we include a dummy crisis variable to capture the effects of the crisis on the dependent variable. The dummy crisis variable takes the value 1 from 2009 although the outbreak of the Subprimes crisis could match with the Lehman Brothers bankruptcy (2008 :Q3). The time-lapse could be explained by the lagged reaction of fiscal policy to the outbreak of the crisis.

9. See, for instance, Baldi and Staehr (2016) and Medeiros (2012)

Secondly, we include a dummy election variable to control for the deficit bias underlined by literature. The deficit bias corresponds to a government's tendency to increase public deficit more than appropriately for elective reasons. For instance, Wyplosz (2013) shows the widespread presence of deficit bias for the OECD countries. Using an overlapping generation model, Cukierman and Meltzer (1989) show that an election encourages the elected politicians to defer fiscal effort in the future. In the same vein, Alesina and Tabellini (1990) show that electoral defeat forecasting could encourage a government to raise public deficit to harm the next government. Several papers consider this political consideration as Maltritz and Wuste (2015), Checherita-Westphal and Zdarek (2017) and Ayuso-i Casals (2007). Ghosh and al. (2013) also include a political stability index measuring government stability. The election dummy variable takes the value 1 if there was a legislative or executive election in the country concerned in a given year and 0 if otherwise. We have obtained the data from Armingeon and al (2013) until 2011 and from the official electoral calendar of the European Commission after 2011. The detail of electoral years is shown by Table 10 in the appendix.

Thirdly, we consider the existence of national fiscal discipline rules. Indeed, in the eurozone, most countries have introduced more or less binding fiscal rules. Computed by the European Commission, the Fiscal Rule Index (FRI) uses several criteria like political commitment by an authority, automatic correction and sanction mechanisms in case of non-compliance etc. The Fiscal Rule Index is occasionally integrated by the literature like Ayuso-i Casals (2007), Medeiros (2012),[10] and Maltritz and Wuste (2015). Details on FRI of the European Commission is displayed in appendix (see Table 11 in appendix).[11] The fiscal constraining level of each country should influence the fiscal management of the government and the deficit and debt level. Therefore, we include the fiscal rule index to control this.

Fourthly, similarly to Weichenrieder and Zimmer (2015) and Maltritz and Wuste (2015), for instance, we take into account integration into the euro area. We add a dummy variable taking the value 1 from the time after integration into the euro area (from 1999). For countries which integrated the euro area after 1999, we implement the value 1 from the year of integration and 0 before.

10. Ghosh, al (2013) use the IMF arrangement on fiscal rules.
11. the table is based on the European Commission's FRI also explained by Maltritz and Wuste (2015).

Lastly, we consider the impact of the Maastricht Treaty on fiscal policies from 1992. Following Gali and Perotti (2003) and Ayuso-i Casals (2007) we include a dummy variable taking the value of 1 for the post Maastricht period (from 1992).

Using panel data estimations, we cover the 1998 :Q1 - 2017 :Q2 period without missing data. We could cover a larger period but data are not necessarily available for all countries. This is not a problem in panel estimation : given that we select 19 countries, the number of observations is adequate (1482). Despite the debate on the annual and quarterly data, we use quarterly data to maximize the size of series [12]. Moreover, we use seasonally and calendar adjusted data to avoid a noise of quarterly data raised by some papers as explained before. Using time series estimations, we cover the 1990 :Q1 - 2017 :Q2 period because time series estimations require longer data. But, given the data available for some countries, the time series begin from 1993 :Q1 for Latvia and Slovenia ; 1994 :Q1 for Estonia and Slovakia and 1998 :Q1 for Lithuania. Table 3 below summarizes variables used.

TABLE 3 – **Selected variables, notation and sources**

Variables	Definitions	Sources
PB	Primary balance ratio to GDP (net lending or borrowing excluding interest)	DG ECOFIN Economic Forecasts; Directorate-General for Economic and Financial Affairs (Spring 2017)
D	Public debt ratio to GDP (general consolidated gross debt, seasonally and calendar adjusted)	Eurostat
Y	real GDP growth rate (gross domestic seasonally and calendar adjusted)	OECD Statistical ressources
π	inflation rate (Harmonised Indices of Consumer Prices, annual rate of change)	Eurostat
R	ten-year government bond (ten-year government benchmark bond yield)	ECB (statistical data warehouse)
crisis	takes the value 1 from 2009 :Q1 to 2016 :Q1 and 0 before	authors implementation
election	takes the value 1 if there is an election in a given country in a given year and 0 if otherwise	See Armingeon and al (2013) until 2011 and the electoral calendar of the member States of the Council of Europe after
FRI	standardised Fiscal rule index	European Commission Directorate-General borrowing excluding interest)
eur	takes the value 1 from integration into the euro area in a given year and 0 if otherwise	authors implementation
maas	takes the value 1 from 1992 (Treaty of Maastricht)	authors implementation

4.1.2 Panel data estimations and preliminary results

We assess several panel estimation to find the more relevant one. Firstly, a pooled estimation using OLS without country or fixed effects. Even if pooled regression denies the heterogeneity that may exist across countries, this model could be a benchmark. Secondly, we use the Hausman test [13] to add a fixed or random effect. In this case, the Hausman test allows

12. as advised by Schoder (2014), Afonso and Jalles (2017), Berti and al. (2016) or Baldi and Staehr (2016) for instance

13. See Table 12 in appendix.

us to reject the null hypothesis that the random effect model is more appropriate than the fixed effect one. Secondly, we choose to estimate a model using country fixed effects allowing us to have an individual intercept value to capture the heterogeneity across countries. Thirdly, we estimate a final model using a GMM methodology as advised by Krajewski and al. (2016), Berti and al. (2016) and Plodt and Reicher (2015) for instance. They pointed out that OLS could be biased and inconsistent, especially for dynamic equations. We need to add instrument variables and choose lagged values from 1 to 4 for primary balance, business cycle indicator represented by GDP growth rate and public debt ratio [14].

The estimated equation can be expressed as follow :

$$\begin{aligned} PB_{i,t} &= \beta_{PB} PB_{i,t-1} + \beta_D D_{i,t} + \beta_Y Y_{i,t} + \beta_\pi \pi_{i,t} + \beta_R R_{i,t} \\ &+ \beta_{CRIS} CRIS_{i,t} + \beta_{ELEC} ELEC_{i,t} + \beta_{EUR} EUR_{i,t} + \beta_{FRI} FRI_{i,t} + \epsilon_{i,t} \end{aligned} \tag{2}$$

PB is the primary balance ratio to GDP, D public debt ratio to GDP, Y business cycle indicator considered as the GDP growth rate, R ten-year government bond, $CRIS$, $ELEC$, EUR and FRI are respectively the control variables to capture the crisis period, the election years, euro area membership and the FRI. ϵ is the error term, i indicates the countries and t the time period. Finally, we also add a country fixed effect according to the specification of the equation. We note that Maastricht period control is not included because our estimation covers the period 1999 :Q2 - 2017 :Q2. It does not appear useful to include this variable control given that the Maastricht Treaty has been applied from 1992.

To assess the stationarity in panel configuration, we perform several unit root tests [15]. Public debt appears non-stationary, business cycle indicator (GDP growth rate in this paper) seems to be stationary and results for primary budget balance series are more ambiguous. Then, as currently stressed by the literature, in panel configuration, public debt displays a non-stationary process. We find a contrasted result for primary balance while other variables (GDP growth rate, ten-year government bond and inflation) are found to be I(0) [16]. We also perform several statistical tests detailed in the appendix to approve (or not) the results. We firstly display the F-statistic (see Table 14 in appendix) showing the joint influence of expla-

14. Baldi and Staehr (2016) mentioned that panel estimation is robust to a change of instruments

15. Levin, Lin, Chu ; Im, Pesaran, Chu ; Augmented Dicky Fuller Fisher Chi square (ADF Fisher Chi square) and Phillips Perron Fisher Chi square (PP Fisher Chi square) (see Burger and a. (2012), Afonso and Jalles (2017), Baldi and Staehr (2016) and Berti and al. (2016) for instance)

16. See Table 13 in appendix for more details on stationary implication in panel configuration.

natory variables on dependent variables. The test accepts this hypothesis and displays a good sign about the variables used. But the Wald test (see Table 15 in appendix) clearly displays a sign of heterogeneity. Indeed, we assess the hypothesis of homogeneous coefficients in panel structure but the hypothesis is rejected. It would appear that countries are heterogeneous enough to opt for a country-specific analysis. Moreover, a Breush Pagan test (see Table 16 in appendix) displays a sign of heteroscedasticity for the three estimated models. In addition, we can mention the lack of significance of estimated coefficients.

In this context, as highlight by Table 4 below, we can underline that the lagged primary balance clearly appears to have an incentive to improve the current primary balance. A positive impact of public debt shows a sign of sustainability of public debt for all countries in the euro area. But a negative coefficient for growth rate in the long-term (from 1998) seems to be curious. In this case, the panel results should therefore be taken with precaution given the lack of significance, the test statistics and the heterogeneity level of countries. The panel estimation seems like an interesting preliminary step to justify our choice to estimate a country-specific reaction function. Indeed, the rest of the paper is specifically concerned with individual estimation in order to better understand national fiscal behavior in the EMU. From this, we provide a comparative analysis of fiscal behavior.

TABLE 4 – **Estimation results**

	Pooled	country fixed effects	GMM fixed effects
C	-0.1011	-0.6730^{***}	-10.371^{***}
	(0.0717)	(0.1078)	(3.3509)
PB_{t-1}	0.9912^{***}	0.9825^{***}	0.8522^{***}
	(0.0053)	(0.0061)	(0.0917)
D	0.0011^{***}	0.0105^{***}	0.0095^{**}
	(0.0004)	(0.0013)	(0.0287)
Y	-0.0330^{***}	-0.0218^{***}	0.2760^{***}
	(0.0045)	(0.0060)	(0.1056)
π	0.0017	0.0169^{*}	0.4432^{*}
	(0.0073)	(0.0087)	(0.2655)
r	0.0131^{**}	0.0145^{*}	1.6024^{***}
	(0.0058)	(0.0077)	(0.4354)
$CRIS$	0.2038^{***}	0.0539	0.0260
	(0.0374)	(0.0453)	(1.7244)
$ELEC$	0.0565^{*}	0.0465	2.5083
	(0.0338)	(0.0346)	(2.4374)
$EURO$	-0.214^{***}	-0.0921	-0.5190
	(0.0397)	(0.0581)	(2.4855)
FRI	0.0333^{*}	-0.0281	2.1493^{**}
	(0.0175)	(0.0241)	(0.9024)
R-squared	0.9650	0.96662	0.9417
Adjusted R-squared	0.9649	0.9660	0.9311
F-statistic	4467.480	1538.443	
Prob(F-statistic)	0.0000	0.0000	
J-statistic			4.7358
Prob(J-statistic)			0.4489

4.1.3 Time series estimation using error correction models : methodology

Stationarity implication

Time series strategy raised stationarity issues. Even if stationarity implications have previously been mentioned in panel configuration, Krajewski and al. (2016) explain that studying the stationarity country by country could give an idea of the fiscal policy sustainability. More precisely, a lack of stationarity for public debt is a sign of unsustainability, but is far from being a sufficient condition. But they point out that depending on the size of the time series, it could also be useful to perform a unit root test in panel configuration. In individual configuration, we perform the Augmented Dickey Fuller (ADF) and Phillips Perron (PP) unit root tests. The tests the null hypothesis of unit root against the alternative hypothesis of the stationarity. We accept or not the null hypothesis at 1%, 5% and 10% respectively. The results are reported in Table 17 showed in the appendix. Even if the ADF and PP tests are often in disagreement, the primary budget balance, public debt and current account are mostly found to be I(1). Inversely, GDP growth rate is overall I(0) and spread is I(1) in half of the cases. This result should be considered with prudence because several papers show the weaknesses of the unit root tests [17]. Despite some results, displaying the stationarity of GDP growth rate for instance, Berti and al. (2016) also argue the relevance of error correction models to fiscal reaction functions. All the more so, Keele and De Boef (2004) demonstrate that error correction models are appropriate for stationnary data. Indeed, they estimate a model series using stationary data and show the equivalence with other estimations. But, be that as it may, we only consider public debt which is I(1) as the main endogeneous variable in the long-run component. The others are control variables included as exogeneous variables in short-run components. In this sense, we avoid the stationarity consideration in the error correction model dynamics of some variables such as the GDP growth rate.

Cointegration procedure

After having checked the stationarity issues, this step consists in verifying the cointegrating relations between endogeneous variables. The cointegrating relation describes a long-run relationship between the variables. If we find a cointegrating vector, we could estimate an error correction model. Following the Johansen approach, we perform the Trace and max eigenvalue

17. See, for instance, Bohn (1998) which explains this aspect and mentions that is nonetheless possible to regress the primary surplus as cointegration regression. Schoder (2014) also discusses the weaknesses. Berti and al. (2016) also find contrasted results with different order of integration according to the unit root tests.

tests to determine the number of cointegrating vectors. The results of Trace and Max eigenvalue tests indicate one significant cointegrating equation (excepted for Austria). The Max eigenvalue tests indicate no cointegration equation while the Trace test rejects the null hypothesis of no cointegration equation. The summarized results are reported in Table 18 in the appendix.

Specification of the error correction models

Our aim is to assess national fiscal reaction functions and we focus on the heterogeneity implications. We can be inspired by a large amount of literature on fiscal reaction function even if we could point out a lack of country-specific analyses for the euro area countries. In this sense, our methodology is inspired by Fincke and Greiner (2012), Schoder (2014), and Berti and al. (2016). As advised by Legrenzi and Milas (2013) Schoder (2014) and Berti and al. (2016), the error correction model can be useful to describe fiscal policy reaction by estimating long-run and short-run dynamics at the same time. In this sense, we can not only estimate long-run and short-run dynamics but also a speed adjustment from a short-run disequilibrium toward the long-run equilibrium.

Our specification is based on current literature using main variables described. Then, the long-run relationship only concerns the public debt impact. We consider public debt as an endogeneous variable to highlight sustainability (respectively unsustainability) issue. We consider other macroeconomic and control variables as exogeneous variables given the stationarity issues. As a consequence, the country-specific fiscal reaction function estimated can be expressed as follows :

$$\Delta PB_{i,t} = \rho(PB_{i,t-1} + \beta_D D_{i,t-1}) + \sum_{n=1}^{2} \alpha_{PB} \Delta PB_{i,t-n} + \sum_{n=1}^{2} \alpha_D \Delta D_{i,t-n} + \alpha_Y Y_{i,t} + \alpha_\pi \pi_{i,t} + \alpha_R R_{i,t}$$
$$+ \alpha_{CRIS} CRIS_{i,t} + \alpha_{ELEC} ELECi,t + \alpha_{FRI} FRI_{i,t} + \alpha_{MAAS} MAAS_{i,t} + \alpha_{EUR} EUR_{i,t} + \epsilon_{i,t} \tag{3}$$

PB is the primary balance ratio to GDP, D public debt ratio to GDP, Y business cycle indicator considered as the GDP growth rate, R ten-year government bond, $CRIS$, $ELEC$, EUR and FRI are respectively the control variables to capture the crisis period, the election years, euro area membership and the FRI. ϵ is the error term, i indicates the countries and t the

time period. ρ is the error correction term and Δ denotes variables expressed in first differences.

The long-run component expresses the level variables. This component displays the cointegrated relationship as long-run target of primary balance. The short-run component is represented by a specification as feedback towards the target (the long-run equilibrium). Then, variables are expressed in first differences showing the growth rate between time t and $t-1$ to only capture the short-run variation one period by period. The error correction term ρ captures the adjustment back mechanism (speed adjustment) of the possible short-run disequilibrium of the primary balance from the long-run one. A coefficient significantly less than 0 indicates that the deviation from long-run equilibrium is corrected gradually through a series of partial adjustments quarter by quarter for our estimation. But, a coefficient less than -1 does not make sense because the short-run deviation from the long-run equilibrium cannot be overcompensated. Similarly, a positive coefficient fails to correct the short-run disequilibrium from the long-run path. The endogeneous variable attached to ρ indicates the long-run component as previously explained. The short-run component is expressed by the endogeneous lagged in first difference and by all control variables. We select four lags (quarters) for the short-run component involving endogenous variables. Too long lag selection raises the estimated coefficients higher and could be estimated to be an inappropriate model.

4.2 Main lessons of time series estimations

Time series estimations presented in the table 5 below for 19 EMU Member States for the 1990-2017 period enables us to draw lessons both in terms of common trends and differences between national fiscal reaction functions of eurozone countries.

Before going into detail, among the major lessons from this analysis, three general and striking results are worth highlighting now : (1) factors explaining national fiscal reaction function in the short run differ from those in the long run, (2) some explanatory variables seem common to all countries while others only concern a small number of countries and (3) the sign of the impact of these explanatory variables can also differ between the countries.

TABLE 5 – **Estimation results**

	Austria	Belgium	Cyprus	Estonia	Finland	France	Germany	Greece	Ireland	Italy
					error correction terms					
rho	$-0,1314^{***}$	$-0,3220^{***}$	$-0,2574^{***}$	$-0,2241^{***}$	$-0,1998^{***}$	$-0,2004^{***}$	$-0,1974^{***}$	$-0,3547^{***}$	$-0,2145^{***}$	$-0,3647^{***}$
	(0,0356)	(0,0541)	(0,0451)	(0,02999)	(0,031)2	(0,0347)	(0,0368)	(0,0309)	(0,04011)	(0,2996)
					long-run coefficients					
β_D	$0,4510^{**}$	$0,6614^{***}$	$0,3417^{***}$	$0,9416^{*}$	$0,2984^{**}$	$0,0991^{***}$	$0,8779^{***}$	$-0,9140^{*}$	$0,0947^{**}$	$-0,7541^{**}$
	(0,2210)	(0,2453)	(0,1247)	(0,1977)	(0,2090)	(0,1405)	(0,2711)	(0,3456)	(0,1263)	(0,3105)
					short-run coefficients					
ΔPB_{t-1}	$0,4478^{***}$	$0,6178^{***}$	$0,1415^{*}$	$0,7265^{**}$	$0,1993^{**}$	$0,0897^{**}$	$0,7461^{***}$	$0,5638^{***}$	$0,0894^{*}$	$0,7116^{***}$
	(0,1240)	(0,1467)	(0,1673)	(0,1940)	(0,0963)	(0,0134)	(0,1569)	(0,1147)	(0,0991)	(0,1649)
ΔPB_{t-2}	$0,4212^{***}$	$0,5944^{**}$	$0,1217^{*}$	0,6432	$0,1736^{**}$	$0,0801^{*}$	$0,5950^{***}$	$0,5401^{***}$	$0,0744^{*}$	$0,4744^{*}$
	(0,1230)	(0,1401)	(0,1600)	(0,1768)	(0,0956)	(0,0124)	(0,1532)	(0,1041)	(0,0913)	(0,1559)
ΔPB_{t-3}	$0,1334^{*}$	0,4517	0,1106	0,4671	$0,1479^{*}$	0,0706	$0,4619^{**}$	$0,4661^{*}$	0,0702	$0,4434^{*}$
	(0,1110)	(0,1317)	(0,1541)	(0,1631)	(0,0887)	(0,0125)	(0,1409)	(0,1006)	(0,0901)	(0,1413)
ΔPB_{t-4}	$0,1144^{**}$	0,4213	0,105	0,4124	$0,1215^{**}$	0,0457	$0,4124^{**}$	0,1954	0,0475	0,4121
	(0,1021)	(0,1214)	(0,1447)	(0,1369)	(0,0856)	(0,0134)	(0,2347)	(0,1217)	(0,0953)	(0,1325)
ΔD_{t-1}	0,0941	0,124	0,1236	0,1477	0,2364	0,147	0,6324	$0,3125^{**}$	0,3641	$0,3214^{**}$
	(0,0145)	(0,0214)	(0,0479)	(0,1124)	(0,2354)	(0,0969)	(0,2416)	(0,2682)	(0,2269)	(0,2134)
ΔD_{t-2}	$0,1214^{**}$	$0,2036^{*}$	0,1478	0,1936	$0,2456^{**}$	$0,1347^{*}$	$0,6578^{**}$	0,3694	$0,3214^{**}$	0,4452
	(0,0987)	(0,1134)	(0,1174)	(0,1093)	(0,1336)	(0,1414)	(0,1206	(0,1100)	(0,0996)	(0,8741)
ΔD_{t-3}	$0,2547^{***}$	$0,236^{*}$	$0,2365^{*}$	0,3574	$0,2687^{***}$	$0,1369^{**}$	$0,6985^{***}$	0,5569	$0,4157^{**}$	$0,4789^{*}$
	(0,1102)	(0,1237)	(0,1319)	(0,1328)	(0,1343)	(0,1530)	(0,1024)	(0,1034)	(0,1402)	(0,1302)
ΔD_{t-4}	$0,3564^{***}$	$0,4786^{***}$	$0,3105^{***}$	$0,4698^{**}$	$0,2904^{***}$	$0,5417^{**}$	$0,7041^{***}$	$0,6047^{**}$	$0,0987^{**}$	$0,4989^{***}$
	(0,1563)	(0,1514)	(0,1574)	(0,1536)	(0,1874)	0,1142)	(0,1364)	(0,1023)	(0,1417)	(0,1700)
					economic determinants					
Y	$0,5050^{*}$	$-0,0901^{***}$	$0,1452^{**}$	0,1645	$0,4745^{**}$	$0,1789^{*}$	$0,6541^{**}$	$0,8784^{**}$	$0,9453^{***}$	$0,0145^{***}$
	(0,2136)	(0,2201)	(0,1475)	(0,1369)	(0,2647)	(0,1647)	(0,1995)	(0,2131)	(0,2974)	(0,0963)
π	$0,0974^{***}$	$-0,3331$	$-0,25^{***}$	-0,2547	$0,1476^{***}$	-0,1347	$0,4687^{***}$	$-0,5478^{***}$	$0,0974^{**}$	$-0,9945^{***}$
	(0,0468)	(0,0977)	(0,9653)	(0,1136)	(0,1039)	(0,1005)	(0,1574)	(0,1640)	(0,1894)	(0,1412)
R	$0,6433^{**}$	0,1467	$0,6478^{***}$	0,1647	-0,1658	0,1478	$-0,9647^{***}$	$0,8496^{***}$	$0,0974^{**}$	$0,4777^{**}$
	(0,2013)	(0,1247)	(0,2446)	(0,1647)	(0,1340)	(0,1023)	(0,2801)	(0,2146)	(0,0194)	(0,0998)
					control variables					
CRIS	0,1479	$-0,1347^{*}$	$-0,2475^{***}$	$-0,3348^{***}$	$-0,3471^{***}$	$-0,4743^{*}$	-0,2104	$-1,1413^{***}$	$-1,1694^{***}$	$-0,9144^{**}$
	(0,1203)	(0,2123)	(0,1495)	(0,0903)	(0,1114)	(0,1731)	(0,252)	(0,2102)	(0,2428)	(0,1475)
ELEC	0,1141	-0,0936	$-0,2304^{*}$	-0,3154	0,1038	$-0,5014^{***}$	$0,1411^{*}$	$-0,9631^{***}$	$0,1475^{**}$	$-0,3674^{***}$
	(0,0740)	(0,1008)	(0,0882)	(0,0930)	(0,0514)	(0,0136)	(0,0213)	(0,1143)	(0,0954)	(0,0843)
FRI	1.9940^{***}	0.1877^{*}	0.6540^{***}	-0.3436	-0.4158	0.1717	0.1532^{*}	0.4100^{***}	0.9705^{***}	0.0587^{*}
	(0.4395)	(0.0345)	(0.1893)	(0.1705)	(0.2621)	(0.0297)	(0.0669)	(0.2218)	(0.3129)	(0.0714)
MAAS	0,1463	$0,1746^{***}$	$0,4172^{**}$	0,0974	$0,3647^{**}$	$0,5741^{***}$	$0,1369^{*}$	0,9874	$0,8475^{*}$	$0,6493^{*}$
	(0,0888)	(0,1423)	(0,1235)	(0,0940)	(0,1053)	(0,1041)	(0,1106)	'0,1340)	(0,1453)	(0,1139)
EURO	0.9985^{***}	0.3417	-1.4716^{*}	1.6541^{***}	0.1943	0.9470^{*}	0.3477^{***}	-0.9631^{***}	-0.4537	0.1433^{**}
	(0.4395)	(0.0345)	(0.1893)	(0.1705)	(0.2621)	(0.0297)	(0.0669)	(0.2218)	(0.3129)	(0.0714)

	Latvia	Lithuania	Luxembourg	Malta	Netherlands	Slovakia	Slovenia	Portugal	Spain
					error correction terms				
ρ	-0.1475^{***}	-0.1456^{***}	-0.0978^{***}	-0.1147^{***}	-0.1963^{***}	-0.3321^{***}	-0.2214^{***}	-0.2924^{***}	-0.2667^{***}
	(0.0518)	(0.0300)	(0.0178)	(0.0512)	(0.0196)	(0.0476)	(0.0813)	(0.0306)	(0.0607)
					long-run coefficients				
β_D	0.0117^{**}	0.2008^{***}	0.7841^{***}	0.3624^{***}	0.2741^{**}	0.2148^{**}	0.1669^{*}	-0.1754^{***}	-0.2426^{***}
	(0.0298)	(0.0807)	(0.2222)	(0.0094)	(0.0516)	(0.0432)	(0.0301)	(0.0217)	(0.0624)
					short-run coefficients				
ΔPB_{t-1}	0.5152^{***}	0.6321^{***}	0.7896^{***}	0.6745^{***}	0.5641^{***}	0.4971^{***}	0.6923^{***}	0.6828^{***}	0.6231^{***}
	(0.1114)	(0.1421)	(0.1324)	(0.1245)	(0.1129)	(0.1018)	(0.0996)	(0.1341)	(0.1225)
ΔPB_{t-2}	0.1403	0.1732	0.7089^{***}	0.8096^{***}	0.8106	0.1328^{**}	0.2801^{**}	0.3494^{*}	0.9641^{**}
	(0.1200)	(0.1110)	(0.0994)	(0.0943)	(0.1060)	(0.1041)	(0.0963)	(0.1234)	(0.1349)
ΔPB_{t-3}	0.4117^{*}	0.7796	0.8053	0.2143	0.5146^{**}	0.5013^{***}	0.1679	0.3254^{**}	0.9431
	(0.1143)	(0.1507)	(0.0799)	(0.1452)	(0.1327)	(0.0964)	(0.0886)	(0.0769)	(0.0931)
ΔPB_{t-4}	0.1821^{**}	0.3465	0.4067	0.3017	0.0974^{**}	.0943	0.5536^{**}	0.3164	0.3614^{*}
	(0.0644)	(0.0943)	(0.0909)	(0.1034)	(0.2013)	(0.1142)	(0.1364)	(0.1440)	(0.1212)
ΔD_{t-1}	-0.5214	-0.4451^{*}	0.1726	-0.3122^{*}	0.0909^{***}	-0.1006^{**}	-0.4128^{**}	-0.0104	-0.1374
	(0.0519)	(0.0333)	(0.0312)	(0.0645)	(0.0689)	(0.0741)	(0.1615)	(0.0314)	(0.1024)
ΔD_{t-2}	-0.1299^{*}	-0.4236^{**}	0.0417	-0.0936	0.8525	-0.1437	0.0657	-0.1237^{**}	-0.2367
	(0.0627)	(0.0473)	(0.0361)	(0.0500)	(0.0641)	(0.0631)	(0.0143)	(0.0316)	(0.1047)
ΔD_{t-3}	-0.2141	-0.0732^{*}	0.1474	-0.1863^{*}	0.0987^{***}	-0.3264	-0.9478^{**}	-0.0974	-0.1648
	(0.0769)	(0.1136)	(0.0775)	(0.2030)	(0.0465)	(0.1313)	(0.0950)	(0.0743)	(0.4400)
ΔD_{t-4}	-0.2147^{*}	-0.7718^{**}	0.2909^{***}	-0.4177^{**}	0.8639	-0.9910	0.3966^{*}	-0.7790^{**}	-0.5623^{**}
	(0.0746)	(0.0645)	(0.0931)	(0.0641)	(0.0996)	(0.0653)	(0.0556)	(0.0399)	(0.1366)
					economic determinants				
Y	-0.1344^{***}	0.6321^{***}	-0.3142^{**}	0.1369	0.2536^{***}	0.3124^{***}	0.0995	0.0974^{**}	-0.1120
	(0.0014)	(0.0236)	(0.0078)	(0.0319)	(0.0674)	(0.0285)	(0.0364)	(0.0347)	(0.0029)
π	-0.1595^{***}	-0.1483^{*}	-0.0317	0.1361	0.1123^{**}	0.1364^{***}	0.1647^{***}	-0.1126^{*}	0.0951^{**}
	(0.0134)	(0.0321)	(0.0400)	(0.0295)	(0.0402)	(0.0231)	(0.0644)	(0.0261)	(0.0634)
R	-0.1997^{**}	-0.0963	0.0621	0.1465	0.4707^{*}	-0.0935	-0.3691^{**}	0.0136	-0.3146^{**}
	(0.0303)	(0.0341)	(0.1054)	(0.0672)	(0.2416)	(0.0683)	(0.1022)	(0.0509)	(0.0601)
					control variables				
$CRIS$	0.1744	0.2929	-0.1743^{***}	0.3156^{***}	-0.5647^{***}	-0.3696^{*}	-0.1412	-0.7952^{***}	-0.5536^{**}
	(0.1203)	(0.2123)	(0.1495)	(0.0993)	(0.1114)	0.1731)	(0.2520)	(0.2102)	(0.2428)
$ELEC$	-0.0921	0.3017^{***}	-0.2104	-0.2628^{**}	-0.0992	-0.4987^{***}	0.1863	0.1643^{*}	-0.3472^{***}
	(0.0740)	(0.1008)	(0.0882)	(0.0934)	(0.0514)	(0.0136)	(0.0213)	(0.0863)	(0.1206)
FRI	-0.0234	0.4531	-0.0643	0.4633^{*}	0.6449^{***}	0.3785^{***}	-0.4656	-0.6231	0.1307^{***}
	(0.0508)	(0.1274)	(0.1309)	(0.0970)	(0.1113)	(0.0943)	(0.0317)	(0.1353)	(0.1634)
$MAAS$	0.4546^{*}	0.3903^{***}	1.9431	0.3111^{*}	0.9733^{***}	0.0941	0.3264^{**}	0.3122	0.2603
	(0.0563)	(0.1217)	(0.0690)	(0.3141)	(0.1224)	(0.1320)	(0.2693)	(0.1237)	(0.1470)
$EURO$	0.3064^{**}	0.4044	1.6354^{***}	1.6645	0.8455^{*}	0.8406	0.6314^{*}	-0.4620^{**}	0.9700
	(0.1241)	(0.1341)	(0.1333)	(0.4332)	(0.2130)	(0.0944)	(0.0969)	(0.2110)	(0.2306)
Obs	98	78	110	110	110	94	98	110	110
R^2	0.8623	0.7204	0.7517	0.6633	0.8324	0.7655	0.6107	0.7997	0.8001

4.2.1 Overview of national fiscal reaction functions in the EMU

In the long run, for most of countries, public debt significantly affects primary balances (except for Greece, Italy, Portugal and Spain). In addition, the estimated long-run adjustment coefficient is negative. It means that the trajectory of the primary balance is still converging towards its long-term trend over the period.

In the short run, for all countries, past primary balances positively affect current primary balance, but higher the lags, the less important the effect (all countries are significantly affected by ΔPB_{t-1} but only 7 of them by ΔPB_{t-4}). Past public debts also affect current primary balance, the higher the lags, the higher the impact (17/19 countries are significantly

affected by ΔD_{t-4} but only 7 by ΔD_{t-1}). However, the sign of the impact depends on the country considered. Moreover, primary balances are most significantly and positively affected par GDP growth rate (12 of 19 countries). The inflation rate significantly affects primary balance for 14 countries, half of them are positively/negatively affected. The impact of the long-term interest rate is less significant because of contrasted results with a positive (negative) impact for only 5 (4) countries. Financial market pressure seems to be non sufficient to improve primary balances. For control variables, it appears that the 2008 economic crisis has mostly negatively affected countries (13 of 19 countries). A significant deficit bias is found for 7 countries and 2 countries seem to be affected by a reverse deficit bias. The pressure of institutional fiscal rules significantly improves primary balance in 10 countries. Maastricht criteria have significantly improved primary balance in 11 countries. Membership of the euro area has improved primary balance in 9 countries.

Besides, country-specific estimations lead to the highlighting of many results which allow us to focus on similarities and differences between the fiscal behavior of EMU countries as we will see now (see. The Table 19 in appendix for more details on results).

4.2.2 Different risks of fatigue fiscal according to country and time horizon

Our estimations allow us to display the long-run coefficients of public debt, showing the sustainability of public debt (respectively a sign of fatigue fiscal). As frequently shown by the literature and primilarly by Bohn (1998), a positive coefficient indicates a positive response of primary balance to changes in public debt and finally agrees with the public debt sustainability. An increase in public debt should be followed to an increase in primary balance to stabilize the public debt ratio over the next period. Inversely, if primary balance reacts negatively to an increase in public debt, the debt level will increase toward the unsustainability path. Then, higher public debt should improve primary balance, implying higher incentives against public spending while a low public debt allows more budget flexibility. Table 6 summarizes the impact of public debt according to country and time horizon.

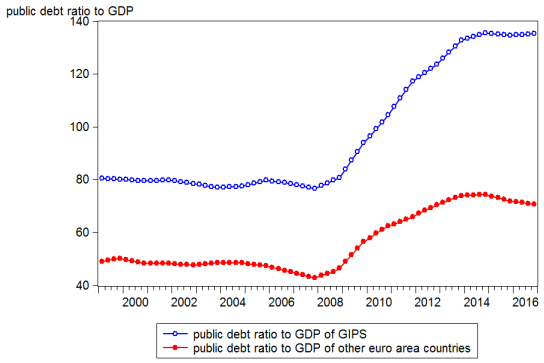
TABLE 6 – **Significant impact of public debts on primary balances**

variable \ countries	FI	FR	DE	AT	BE	IE	CY	NL	EE	LU	LV	LT	MT	SK	SL	IT	GR	PT	ES
long-run	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-	-
																Sign of fiscal fatigue			
short-run																			
lag 1	+							+				-	-	-	-	+	+		
lag 2	+	+	+	+	+	+					-	-			-			-	
lag 3	+	+	+	+	+	+	+	+				-	-		+	+			
lag 4	+	+	+	+	+	+	+		+	+	-	-	-			+	+	-	-
	+	+	+	+	+	+	+		+	+	Opposition between short and long-run							-	-

Sign of fiscal fatigue for Greece, Italy, Portugal and Spain.

Our results suggest that most countries display a sustainable public debt in the long run. But, Greece, Italy, Portugal and Spain [18] display a sign of fiscal fatigue. Graph 2 below shows the evolution of public debt, distinguishing two groups of countries. We can clearly see that PIGS have not only a higher initial public debt level but they also have been more impacted by the sovereign debt crisis.

Graph 2 : Evolution of public debt for "unsustainable" and "sustainable" groups of countries (1999-2016)



Source : Eurostat

We could related our result with several previous papers. Firstly, Krajewski and al. (2016) show overall that Central and Eastern european countries displayed a sustainable public debt path despite the financial turmoil. Our estimations display a positive coefficient of public debt for all Central and Eastern euro area countries. Second, Schoder (2014) finds a lack of sustainability for Greece and Portugal but also for France. However, we find opposite results for Spain. In addition, Spain has particularly suffered from the crisis. Indeed, Spain respected the public debt limit of 60% before 2010 and displayed a fiscal surplus. But, in 2016, the public debt of

18. frequently named "the periphery", the southern countries or even PIGS group by Legrenzi and Milas (2013) for instance.

Spain is very close to 100% of GDP and has not recovered the limit of 3%. We also find a lack of sustainability for Italy, given the public debt level path (higher than 100% of GDP from at least 1999 and 132.6% in 2016). However, we have previously seen that Italy displayed a higher primary balance than the euro area on average but, the low GDP growth rate from 1999 prevent her from reducing the debt level. Thirdly, our results are close to Ghosh and al. (2013), finding a precarious fiscal situation for Greece, Italy, Portugal, Spain, but also for Ireland. Like Spain, Ireland also have suffered particularly from the crisis because the public debt has increased from 23.9% of GDP in 2007 to 75.4% with a peak in 2012 at 119.5%. Ireland is a specific case due to the financial sector turmoil but the country seems to recovering a sustainable fiscal path. Indeed, Ireland displayed a government budget balance at -0.6% of GDP in 2016.

Some countries show different fiscal risks according to the time horizon

In opposition to the decreasing effect of lagged primary balance through time, we find that the higher the lags (from 1 to 4), the more lagged public debt affects current primary balance. In this sense, public debt is a minor determinant of primary balance in the short-run but a major determinant in the long-run. Indeed, 17 countries are significantly affected by public debt with 4 lags and 7 countries with 1 lag. These results are consistent with the long-run analysis showing that public debt significantly affects all countries.

In addition, we note a heterogeneous sign of public debt coefficients. 12 (7) countries seem to be positively (negatively) affected by public debt showing a sustainability path (sign of fiscal fatigue). Moreover, some countries display the same sign in the long-run and in the short-run, while other countries display inverse impact of public debt in the long-run and in the short-run. In this context, it is possible to distinguish four different cases :

— Public debt sustainability in the long and short-run : public debt positively affects primary balance for both time distinctions for *Austria, Belgium, Cyprus, Estonia, Finland, France, Germany, Ireland, Luxembourg, Netherlands.*

— Fiscal fatigue in the long and short-run : public debt negatively affects primary balance for both time distinctions for *Portugal, Spain.*

— Public debt sustainability in the long-run but fiscal fatigue in the short-run : public debt positively affects primary balance in the long-run but, negatively in the short-run for *Latvia, Lithuania, Malta, Slovakia, Slovenia.*

— Fiscal fatigue in the long-run but sustainable public finance in the short-run : public debt negatively affects primary balance in the long-run, but, positively in the short-run for *Greece, Italy.*

We could probably invoke the crisis impacts to explain a change of sign through time for some countries. We could assume that Greece and Italy display a sign of fiscal fatigue in the long-run but, in the short-run, fiscal consolidation and European assistance have made it possible to strongly reduce the deficit to avoid the risk of sovereign bankruptcy. Inversely, we could assume that some Eastern countries (and Malta) have a long-run sustainable public debt but, in the short-run, crisis impacts have strongly deteriorated primary balance as a risk for public finance.

4.2.3 Adjustment speed and past primary balance impact

A link between adjustment speed toward the long-run equilibrium and public debt level

As mentioned before, the error correction term (ρ) describes the adjustment speed towards the long-run equilibrium. An error correction term at -0.10 can be interpreted such as a short-run deviation is corrected by 10% per period (quarter) towards the long-run equilibrium. All estimated error correction terms are significantly between -1 and 0 at 1%, showing a good sign for our methodological choice (see table 7). Moreover, we find a large gap between countries : from 9,78% for Luxembourg (a short-run disequilibrium is corrected by 9.78% per period) to 36.47% for Italy.

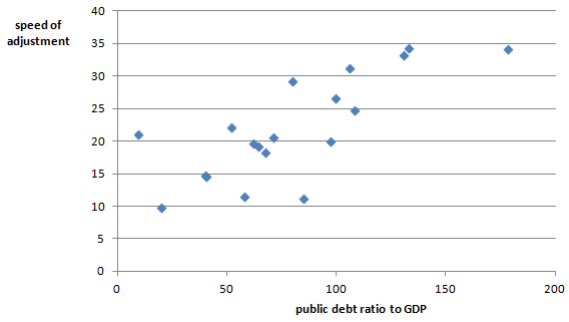
TABLE 7 – **Impact of public finance conditions on primary balance (adjustment speed and impact of past primary balance)**

variable \ countries	IT	GR	SK	BE	PT	CY	ES	EE	SL	IR	FR	FI	DE	NL	LT	LT	AT	MT	LX
adjustment speed	36.47%	35.47%	32.20%	33.21%	29.24%	25.74%	22.67%	22.41%	22.14%	21.45%	20.04%	19.98%	19.74%	19.63%	14.75%	14.56%	13.14%	11.47%	9.78%
short-run																			
lag 1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
lag 2	+	+	+	+	+	+	+		+	+	+	+	+				+	+	+
lag 3	+	+	+		+							+	+	+	+		+		
lag 4					+		+		+			+	+	+	+		+		

Furthermore, there seems to be a link between high public debt level and adjustment speed coefficient (see Scatterplot 4). Belgium, Greece, Italy, Portugal and Spain simultaneously display high public debt (more than 100% of GDP) and high error correction terms. But, we note that Slovakia is also characterized by a higher error correction term despite a low public debt.

This positive relation could be in accordance with Medeiros (2012) finding that fiscal response is higher when public debt to GDP ratio increase. More precisely, when the public debt ratio is close to the unsustainability threshold, fiscal policy reacts more to a change of public debt to avoid crossing the threshold. More generally, our result could also be related to Gali and Perotti (2003), Weichenrieder and Zimmer (2015) and Baldi and Staehr (2016), showing that fiscal policy tends to react more (or, at least, remain unchanged) to a change of public debt over time.

Scatterplot 4 : adjustment speed related to public debt ratio to GDP (2016)



Lagged primary balances encourage governments to improve current primary balance.

We find a homogeneous impact of lagged primary balance on current primary balance for euro area countries (see table 7). Lagged primary balances positively impact current primary balances. Similarly to Maltritz and Wuste (2015), we could assume that a deficit in the previous period encourages a government to reduce the deficit in the next period. Likewise, a surplus in the previous period encourages the government to improve again the surplus in the next period. Moreover, the higher the lags, the less previous primary balance affects the current primary balance. Indeed, all countries are significantly affected by primary balance in the previous period but only 7, by primary balance with 4 lags. Then, it seem as though primary balance is an important determinant affecting current balance, but in the short-run only.

4.2.4 Macroeconomic variables differently affect primary balance

Table 8 summarizes the impact of macroeconomic variables (GDP, inflation rate, interest rates) on national primary balance in the EMU.

TABLE 8 – **Impact of macroeconomic variables on primary balance**

variable \ countries	AT	NL	CY	FI	DE	GR	IE	IT	SK	PT	LT	FR	LV	BE	LU	EE	MT	SL	ES
GDP	+	+	+	+	+	+	+	+	+	+	+	+	-	-	-				
inflation	+	+	-	+	+	-	+	-	+	-	-		-					+	+
10-year government bond	+	+	+		-	+		+					-					-	-

GDP growth rate and primary balance.

We find that GDP growth rate significantly affects primary balance for 12 of 19 countries. As indicated by Gali and Perotti (2003), Checherita-Westphal and Zdarek (2017) and Fincke and Greiner (2012) for France and Italy, this result suggests a sign of counter-cyclical fiscal policy. Indeed, higher GDP growth rate is related to higher tax revenues, lower social public spending improving the public finance situation. Inversely, we find a significant negative impact of GDP growth rate on primary balance for Belgium, Latvia and Luxembourg. This has also been found by Escolano and al. (2012) for a panel of 27 European countries and Fincke and Greiner (2012) for Germany. They highlight a sign of pro-cyclical fiscal policy. In this sense, higher GDP growth rate is related to a deterioration of public finance (lower fiscal surplus or higher deficit) characterized by an increase in public spending more than an increase in tax revenues. In this case, it would appear that fiscal policy fails to ensure the role of shock stabilizer. Moreover, we find a non-significant effect for Estonia, Malta, Slovenia and Spain, suggesting the weakness of the business cycle indicator as underline by Maltritz and Wuste (2015) for some countries.

Asymmetric fiscal behavior in response to inflation rate.

Inflation rate coefficients raise a high level of heterogeneity between EMU countries. In this context, it is possible to distinguish three different cases :

— Positive effect of inflation rate on primary balance (8 of 19 countries) : *Austria, Ireland, Finland, Germany, Netherlands, Slovakia, Slovenia, Spain.* Similarly to Ghosh and al. (2013), Fournier and Fall (2017) and Berti and al. (2016), a positive sign means that inflation improves the primary balance and public finance situation. An increase in in-

flation rate has a stronger effect on tax revenues than public spending. In this sense, a higher inflation rate could often be related to a wage increases allowing income tax and Value Added Tax to be increased due to growth of household consumption.

— Negative effect of inflation rate on primary balance (6 of 19 countries) : *Cyprus, Greece, Italy, Latvia, Lithuania, Portugal.* A negative effect has been mentioned by Ghosh and al. (2013) and Maltritz and Wuste (2015) in panel analysis. Ghosh and al. (2013) state that the inflation rate requires a fiscal effort because of the increase in the public debt burden. Indeed, an increase in the inflation rate is correlated with the interest rate and induces an increase in public debt needing a stronger fiscal effort by the government.

— Non-significant effect of inflation rate on primary balance : *Estonia, France, Belgium, Luxembourg, Malta.*

Financial market pressure seems to be insufficient to improve primary balance.

As explained before, similarly to Fincke and Greiner (2012) and Maltritz and Wuste (2015), we include the long-term interest rate even if we use primary balance because interest payment level affects global fiscal decisions of government and indirectly affects primary balance. Most countries (10 of19 countries) are not significantly affected by the ten-year government bond. As Maltritz and Wuste (2015), our results suggest that financial market pressure is not enough to improve the public finance situation of countries. Furthermore, for countries displaying significant coefficients, we find heterogeneous effects.

— Long-term interest rate improves primary balance for *Austria, Cyprus, Greece, Italy, Netherlands.* Legrenzi and Milas (2013) have also found a positive pressure of long-term interest rate. In this sense, the higher the ten-year government bond, the higher the primary balance also. A higher long-term interest rate could encourage a government to provide a higher fiscal effort to improve the public finance situation and avoid a public debt burden.

— Long-term interest rate deteriorates primary balance for *Germany, Latvia, Slovenia, Spain.* Inversely, we can not see the incentive effect of the financial market. Public finance of these countries deteriorates in response to the increase in the long-term interest rate and public debt burden.

4.2.5 A differentiated impact of socio-institutional variables

Table 9 summarizes the impact of fiscal rules (at national level vith FRI criterium and at the EMU level), entry into the euro area, country's political conditions and the 2008 crisis on national primary balance in the EMU.

TABLE 9 – **Impact of socio-institutional variables on primary balance**

variable \ countries	DE	IT	NL	BE	MT	FR	LV	SL	AT	SK	ES	IE	LT	FI	EE	LU	CY	GR	PT
Fiscal Rule Index	+	+	+	+	+				+	+	+	+			+		+		
Maastricht	+	+	+	+	+	+	+	+				+	+	+			+		
euro area	+	+	+			+	+	+	+						+	+	-	-	-
crisis		-	-	-	+	-				-	-	-		-	-	-	-	-	-
deficit bias +	-			-	-				-	-	+	+				-	-	-	-

Fiscal discipline and euro area membership improve primary balance.

In this framework, fiscal discipline is taken into account at two levels : (i) at national level with the FRI, (ii) at Community level with the Maastricht criteria. We converge toward the analysis of Ayuso-i Casals (2007) and Schoder (2014) by finding that FRI significantly affects primary balance (for 11 out of 19 countries). Moreover, like Schoder (2014), finding that euro area convergence criteria contributed to the sustainability of public debt, our results suggest a positive effects of eurozone fiscal rules on primary balance (for 12 out of 19 countries). Only Estonia, Greece, Luxembourg and Portugal seem to be non-significantly affected by FRI and Maastricht criteria. Belgium, Cyprus, Germany, Italy, Malta and the Netherlands are affected by both, while, Finland, France, Latvia, Lithuania and Slovenia are only affected by Maastricht Treaty. Then, overall, the growth and hardness of fiscal rules contribute to improving the primary balance and public finance situation.

Moreover, several papers have used the role played by the euro membership to explain the fluctuations of fiscal behavior. For instance, Weichenrieder and Zimmer (2015) have shown a larger responsiveness of fiscal policy compared to the period before the Maastricht Treaty. Maltritz and Wuste (2015) have also captured the effect of euro membership using fiscal reaction function. They find that euro membership positively impact (significantly) primary balance for 9 countries. Similarly, our results also suggest that euro membership has improved primary balance for mostly countries (for 9 out of 19 countries). But, we find a significant negative sign for Cyprus, Greece and Portugal, showing that the euro area period has negatively impacted their

primary balance. This result could be related to the crisis period which has largely increased the primary deficit. All the more so as these countries have a common characteristic : they are considered as peripheral countries.

2008 crisis deteriorated primary balance.

We find that the crisis dummy-variable has significantly and negatively affected primary balance for mostly countries (for 13 of 19 countries), as already obtain by Berti and al. (2016) for instance. This result has previously been illustrated in our descriptive analysis section showing a large deterioration of the public finance situation from 2008. But surprisingly we find a positive effect for Malta. In the descriptive analysis section, we have seen that Malta is the only one diplaying a decrease in public debt (-4.1 points of GDP) compared to the public debt level before the onset of the crisis. Moreover, Malta display a fiscal surplus and a public debt lower than 60% of GDP showing a healthy public finance path. In this sense, the crisis period has been a positive factor to implement fiscal effort and improve public finance. Moreover, Austria, Germany, Latvia, Lithuania and Slovenia displays non-significant coefficients. These countries have the same characteristics to display a lower public debt than the euro area on average (see Figure 1), but their heterogeneous country profiles make it difficult to find a common analysis.

Deficit (or reverse deficit) bias in electoral period affects primary balance.

Our results suggest a significant "deficit bias" for 7 of 19 countries : Cyprus, France, Greece, Italy, Malta, Slovakia and Spain, as already underline by Cukierman and Meltzer (1989), Alesina and Tabellini (1990),Ghosh and al. (2013), Wyplosz (2013) and Maltritz and Wuste (2015) for OECD countries. The electoral period deteriorates primary balance because electoral defeat forecasting could incite a government to raise the deficit to harm the next government. Moreover, the newly elected government implements a new public spending from their electoral program. Then, we apply this analysis especially for some South countries (Cyprus, Greece, Italy, Malta) besides France and Slovakia. On the contrary, we can also identify a "reverse deficit bias" (i.e. the electoral context leads to a consolidation of public finances) for 3 of 19 countries : Germany, Lithuania and Portugal. We could assume that each newly elected government implements a new fiscal policy each time to improve public finance. However, it could be surprising to find this result for Portugal because other Southern countries display a significant deficit bias.

5 Conclusion

Finally, the empirical literature on fiscal reaction functions is relatively abundant and provides a wide range of results depending on countries, the time period considered, and the explanatory variables chosen. In this paper, time series estimations for 19 EMU Member States for the 1990-2017 period (using the error correction model) enable us to draw lessons both in terms of common trends and differences between the national fiscal reaction functions of eurozone countries.

Among the major lessons from this analysis, general and striking results are worth highlighting : (1) factors explaining the national fiscal reaction function in the short run differ from those in the long run, (2) some explanatory variables seem common to all countries while others only concern a small number of countries and (3) the sign of the impact of these explanatory variables can also differ between the countries.

More precisely, in the long run, for all countries, public debt significantly affects primary balances (but in a negative manner for Greece, Italy, Portugal and Spain for fiscal fatigue reasons). This result is also found by Schoder (2014) for Greece and Portugal or by Ghosh and al. (2013). But the literature is not unanimously in agreement with the list of countries. We found that adjustment speed toward the long-run equilibrium is related to the public debt level. The higher the public debt, the quicker the adjustment speed, given that governments are more reactive when public debt is close to the unsustainability threshold. We could relate our result to Gali and Perotti (2003) or Weichenrieder and Zimmer (2015) for instance.

In the short run, public debt impact is not necessarily the same compared to the long-run one. Besides, public debt is not the first determinant of primary balance in the short run. For all countries, past primary balances positively affect current primary balance as shown by Maltritz and Wuste (2015), but the higher the lags, the weaker the effect. On the contrary, past public debts also affect current primary balance, but the higher the lags, the higher the impact, and the sign of the impact depends on the country considered. Primary balances are mostly significantly affected by the GDP growth rate and inflation rate. GDP growth rate impact displays a positive or negative coefficient across countries showing a sign of counter-cyclicality or pro-cyclicality of fiscal policy. We find a lack of significance for ten-year government bond showing that incentives of the financial market are not enough to improve primary balance.

For control variables, it appears that the 2008 economic crisis has mostly negatively affected countries (13 of 19 countries) excepted for Estonia and Malta which have improved their primary balance from 2009. Public deficit policy bias is only confirmed for 7 out of 19 countries. We find a deficit bias for some countries, such as France, Greece, Italy or Spain, for instance, frequently shown by the literature. But we find an inverse deficit bias for Portugal and Lithuania, showing that successive governments improve primary balance. On the contrary, the impact of fiscal discipline, whether national or supranational, seems to be confirmed. We agree with Ayuso-i Casals (2007) and Schoder (2014) for instance, showing that fiscal rules tend to improve primary balance. Indeed, institutional national fiscal rules pressure significantly improves primary balance (10 of 19 countries), as do Maastricht criteria (11 of 19 countries). Finally, accession to the euro area has improved primary balance in 9 out of 19 countries.

In spite of common fiscal rules since 1999, our results suggest a strong heterogeneous fiscal behavior and determinants of the fiscal policy. In this context, literature suggests to deepen fiscal coordination or to adopt fiscal federalism. Several extensions of this paper could by considered. Firstly, a technical extension. Indeed, using the error correction framework which include a non-stationary series, we have also included a public debt in the long-run dynamic. Firstly, to analyse the sustainability of public debt, secondly, because the debt series are I(1). We could extend this paper using a other methodology to also include other variables in the long-run dynamics, such as the GDP growth rate of the inflation rate for instance. Secondly, a conceptual extension. In this heterogeneous context, it could be interesting to measure the mutual fiscal-spillovers in a Global Vector Auto-Regressive model. Already implemented by the literature, it could be useful to compare two scenarii. First, the current fiscal situation displaying fiscal spillovers and second, a situation involving a common fiscal authority.

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6 Appendix

TABLE 10 – **Election years in EMU countries (Armingeon and al (2013) ; European Commission)**

Countries	election years						
AT	2017 :Q4	2016 :Q4	2013 :Q3	2010 :Q2	2008 :Q3	2006 :Q4	2004 :Q2
	2002 :Q4	1999 :Q4	1995 :Q4	1994 :Q4	1990 :Q2		
BE	2014 :Q2	2010 :Q2	2007 :Q2	2003 :Q2	1999 :Q2	1996 :Q2	1991 :Q4
CY	2016 :Q2	2013 :Q1	2011 :Q2	2008 :Q1	2006 :Q2	2003 :Q1	2001 :Q2
	1996 :Q1	1993 :Q1	1991 :Q2				
EE	2016 :Q3	2015 :Q1	2011 :Q1	2007 :Q1	2003 :Q1	1999 :Q1	1996 :Q1
	1992 :Q4						
FI	2015 :Q2	2012 :Q1	2011 :Q2	2007 :Q1	2006 :Q1	2003 :Q1	2000 :Q1
	1999 :Q1	1996 :Q1	1994 :Q1	1991 :Q1			
FR	2017 :Q2	2012 :Q2	2007 :Q2	2002 :Q2	1995 :Q3	1993 :Q1	
DE	2017 :Q3	2013 :Q3	2009 :Q3	2005 :Q3	2002 :Q3	1998 :Q3	1995 :Q3
	1995 :Q3	1994 :Q4	1990 :Q4				
GR	2015 :Q3	2012 :Q2	2012 :Q2	2009 :Q4	2007 :Q3	2004 :Q1	2000 :Q1
	1997 :Q1	1993 :Q4	1990 :Q1				
IE	2016 :Q2	2011 :Q4	2007 :Q2	2002 :Q2	1997 :Q2	1995 :Q2	1992 :Q4
	1990 :Q4						
IT	2013 :Q1	2008 :Q2	2006 :Q2	2001 :Q2	1996 :Q2	1994 :Q1	1992 :Q1
LV	2014 :Q4	2011 :Q3	2010 :Q3	2006 :Q4	2002 :Q4	1995 :Q4	1994 :Q1
	1990 :Q1						
LT	2016 :Q4	2012 :Q4	2008 :Q3	2004 :Q3	2002 :Q4	2000 :Q4	1998 :Q1
	1997 :Q2	1995 :Q4	1993 :Q1	1992 :Q4	1990 :Q1		
LU	2013 :Q3	2009 :Q2	2004 :Q2	1999 :Q2	1997 :Q2	1994 :Q2	
ML	2013 :Q1	2009 :Q1	2008 :Q1	2003 :Q2	1998 :Q3	1996 :Q2	1992 :Q2
NT	2017 :Q1	2012 :Q3	2010 :Q2	2006 :Q4	2003 :Q1	2002 :Q2	1996 :Q1
	1996 :Q1	1994 :Q2					
PT	2016 :Q1	2015 :Q3	2011 :Q3	2009 :Q3	2006 :Q1	2005 :Q1	2002 :Q1
	2002 :Q1	2001 :Q1	1999 :Q4	1995 :Q1	1991 :Q1		
SK	2016 :Q1	2012 :Q2	2010 :Q2	2009 :Q1	2006 :Q2	2004 :Q2	2002 :Q3
	1999 :Q2	1997 :Q2	1995 :Q3	1994 :Q4			
SI	2017 :Q3	2014 :Q3	2012 :Q4	2011 :Q4	2008 :Q3	2007 :Q4	2004 :Q4
	2002 :Q4	2000 :Q4	1997 :Q4	1995 :Q4	1992 :Q3		
ES	2016 :Q2	2015 :Q4	2011 :Q4	2008 :Q1	2004 :Q1	2000 :Q1	1997 :Q1
	1993 :Q1						

TABLE 11 – **Evolution of the Fiscal Rule Index (1990-2016) for EMU countries (European Commission)**

Countries	1990	1999	2008	2017
AT	-0.9587	-0,0186	0,2611	0,4872
BE	-0.5094	0,2609	0,0382	1,5392
CY	-0,8925	-0,8925	-0,8925	0,9491
EE	-0,9587	0,7428	0,7428	1,2594
FI	-0,9587	0,5815	0,2702	1,3405
FR	-0,6436	-0,2498	0,3536	3,0335
DE	0,3349	0,3349	0,3349	2,8954
GR	-0,9587	-0,9587	-0,9587	0,7671
IE	-0,9587	-0,9587	-0,7565	1,9483
IT	-0,9587	-0,4781	0,0732	3,5275
LV	-0,9587	-0,3765	-0,3765	2,9260
LI	-0,7174	-0,0997	0,5136	3,0871
LU	-0,8379	0,4777	1,1679	2,0019
MT	-0,9587	-0,9587	-0,9587	1,9222
NT	-0,9587	0,4438	0,4438	2,7564
PT	-0,9587	-0,9587	-0,2060	2,4302
SK	-0,9587	-0,9587	-0,9587	-0,9587
SI	-0,9587	-0,9587	-0,0008	2,5212
ES	-0,3831	-0,3831	1,1257	2,9135

TABLE 12 – **Hausman test**

Test cross-section random effects	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	60.911248	9	0.0000
We can reject null hypothesis of appropriate random effects			

TABLE 13 – **Unit root tests on endogeneous variables (panel configuration)**

	PB	D	Y	R	π
Levin, Lin, Chu I(0)	I(1)	I(0)	I(0)	I(0)	I(0)
Im, Pesaran, Chin PB	I(0)	I(1)	I(0)	I(0)	I(0)
ADF Fisher Chi-square PB	I(0)	I(1)	I(0)	I(0)	I(0)
PP Fisher Chi-square PB	I(1)	I(1)	I(0)	I(0)	I(0)

TABLE 14 – **Statistical tests**

F-statistic	Value	df	Probability
Pooled	4897.023	(8,1452)	0.0000
fixed effects	3502.137	(8,1434)	0.0000
GMM	89.60158	(8,1353)	0.0000
Explanatory variables jointly can influence independent variable			

TABLE 15 – **Wald test**

Test Statistic chi-square	Value	df	Probability
Pooled	39176.19	8	0.0000
fixed effects	28017.10	8	0.0000
GMM	716.8126	8	0.0000
We can accept alternative hypothesis of heterogeneous coefficients			

TABLE 16 – **Breush Pagan Godrey heteroscedasticity test**

Breush Pagan Godrey heteroscedasticity test	Statistic	d.f.	Prob.
Pooled	932.4134	171,0000	0.0000
fixed effects	928.1748	171	0.0000
GMM	1782.383	171	0.0000
We can accept alternative hypothesis of heteroscedasticity			

TABLE 17 – **Unit root tests on endogeneous variables (individual configuration)**

	PB		D		Y		R		π	
	ADF	PP	ADF	PP	ADF	PP	ADF	PP	ADF	PP
AT	I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(1)	I(0)	
BE	I(1)	I(1)	I(1)	I(1)	I(0)	I(0)	I(1)	I(1)	I(0)	
CY	I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)	I(1)	
EE	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(0)	I(0)	I(1)	
FI	I(0)	I(1)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)	I(0)	
FR	I(1)	I(1)	I(1)	I(1)	I(0)	I(0)	I(1)	I(1)	I(1)	
DE	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(1)	I(1)	I(0)	
GR	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	I(1)	
IE	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(1)	I(0)	
IT	I(1)	I(1)	I(0)	I(1)	I(0)	I(0)	I(1)	I(1)	I(1)	
LV	I(0)	I(1)	I(0)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	
LT	I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(0)	I(0)	I(0)	
LU	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(1)	I(1)	I(0)	
MT	I(1)	I(0)	I(1)	I(0)	I(0)	I(0)	I(0)	I(0)	I(0)	
NL	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(0)	I(0)	I(1)	
PT	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(1)	I(1)	I(1)	
SK	I(0)	I(1)	I(0)	I(1)	I(0)	I(0)	I(0)	I(0)	I(0)	
SI	I(1)	I(1)	I(1)	I(1)	I(0)	I(1)	I(0)	I(0)	I(0)	
ES	I(2)	I(1)	I(2)	I(1)	I(1)	I(1)	I(1)	I(1)	I(0)	

TABLE 18 – **Johansen cointegration test**

hypothesized no of cointegrating equation(s)	Trace statistic	critical value	Max-eigen statistic	critical value	Trace statistic	critical value	Max-eigen statistic	critical value
	Trace statistic	Critical value	Max-eigen value	Critica value	Trace statistic	Critical value	Max-eigen value	Critica value
	Austria				Belgium			
None	26.4789	31.2417**	17.8417	21.4535*	33.1213	12.6741***	32.0347	110.2285***
At most 1	7.3682	12.2656	7.1002	12.5681	1.2114	7.1777	1.0238	6.1839
	Cyprus				Estonia			
None	38.4110	24.2321***	34.1336	18.4741***	61.3619	21.2361***	51.0302	19.2037***
At most 1	3.0147	13.2564	3.2134	13.6851	7.0031	14.0136	76.6623	11.231
	Finland				France			
None	44.4451	26.364***	32.3169	18.2300***	30.0364	13.0318***	25.8216	10.2133***
At most 1	8.0117	11.5186	8.9014	13.6393	3.1214	7.4131	1.2300	5.0304
	Germany				Greece			
None	22.2313	111.3491***	228.8470	10.0131***	37.7474	12.3198***	38.8554	12.8546***
At most 1	1.1213	6.1852	1.2009	5.001	2.9744	6.2124	2.0377	5.6966
	Ireland				Italy			
None	31.4112	19.9784***	24.2333	15.3221***	36.6473	24.6171***	22.6310	19.9744***
At most 1	4.2223	10.0014	5.6569	10.6796	10.1410	14.1447	9.0699	12.9585
	Latvia				Lithuania			
None	28.5562	12.2321***	25.5231	12.2246***	36.4168	12.8189***	34.8743	12.4167***
At most 1	2.2018	5.0199	2.0989	4.56211	1.5090	5.0174	1.5396	5.0131
	Luxembourg				Malta			
None	54.2311	25.3630***	26.6241	18.4778***	32.3266	12.0311***	30.2746	11.2248***
At most 1	23.5614	12.51798***	23.5614	12.51798***	1.6381	4.1299	1.6381	4.1299
	Netherlands				Portugal			
None	47.5201	12.3209***	47.1090	11.2248***	32.3921	12.3209***	31.2423	11.05877***
At most 1	1.2000	4.4463	1.1134	6.1818	1.1411	4.3326	1.7339	5.1374
	Slovakia				Slovenia			
None	42.2855	12.3388***	40.1779	10.6336***	45.6439	11.9987***	44.3657	10.2886***
At most 1	1.1717	5.6699	2.6317	4.9978	1.2336	7.7874	1.1127	5.6963
	Spain							
None	32.1140	24.6339***	20.3646	18.3177**				
At most 1	6.6789	13.3114	6.4741	12.9884				

TABLE 19 – **Estimation results (significant)**

backslashboxvariablecountries	AT	BE	CY	EE	FI	FR	DE	GR	IE	IT	LV	LT	LU	MT	NL	SK	SL	PT	ES
Public debt	+	+	+	+	+	+	+	-	+	-	+	+	+	+	+	+	+	-	-
Primary balance																			
lag 1	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+	+
lag 2	+	+	+		+	+	+	+	+	+			+	+		+	+	+	+
lag 3	+				+		+	+		+	+				+	+		+	
lag 4	+				+						+				+		+		+
public debt																			
lag 1								+		+		-		-	+	-	-		
lag 2	+	+			+	+	+		+		-	-						-	
lag 3	+	+	+		+	+	+		+	+	+				+	+		+	
lag 4	+	+	+	+	+	+	+	+	+	+	-	-	+	-			+	-	-
GDP	+	-	+		+	+	+	+	+	+	-	+	-		+	+		+	
Inflation	+	-	-		+		+	-	+	-	-	-			+	+	+	-	+
10-year government bond	+		+				-	+	+	+	-				+		-		-
Fiscal Rule Index	+	+	+				+		+	+				+	+	+			+
Maastricht		+	+		+	+	+			+	+	+		+	+		+		
Euro	+		-	+		+	+	-		+	+		+		+		+	-	
Crisis		-	-	-	-	-		-	-	-			-	+	-	-		-	-
deficit bias			-			-	+	-	+	-		+		-		-		+	-