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FISCAL SUSTAINABILITY IN CENTRAL AND EASTERN EUROPE : FISCAL REACTION FUNCTION PERSPECTIVE

Master's thesis

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Name and signature of supervisor.....

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Abstract

The purpose of the paper is to analyze the sustainability of public finances in the set of 10 Central and Eastern European countries during 1995-2015. We estimate parameters of the fiscal reaction function using fixed effects GLS model. Our results show that the primary balance is persistent and appears to be extra reactive to increasing public debt (in a corrective manner) and to business cycle fluctuations (in a countercyclical manner) in line with the recent literature implying fiscal sustainability in CEE countries. After the crisis in 2008 the fiscal response gets even more reactive to the debt, however, turning to acyclical. We also find evidence of the 'fiscal fatigue' during the crisis and post-crisis periods. Finally, the change in fiscal response to interest payments, old age dependency ratio and fiscal rule index variables points to the shift in priorities of the fiscal authorities as an aftermath of the crisis. All the sudden changes give reason to pay extra attention to the topic and conduct further research.

Key words: debt sustainability, fiscal policy reaction function (FPRF), fiscal fatigue, Central and Eastern Europe.

JEL: E62, H63, C33

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1. Introduction

The concern over ever-increasing debt burden is far from new. Fiscal sustainability is a recurrent point of discussion with almost two hundred year history. For a long time fiscal sustainability and economic growth was considered as conflicting objectives. The financial literature of the previous decades, argues that the economy needs to tolerate some positive debt level. If a country has not enough financial deepening it would have lower economic growth (see, for example, Goldsmith (1969), McKinnon (1973), Shaw (1973) and more recently King and Levin (1993)). As a result, debt funding has become common practice in the advanced economies.

The recent increase in the debt-to-GDP ratios following the last economic downturn has become a wake-up call for governments in most advanced economies to deal with unsustainable budgetary plans. Figure 1 shows the evolution of public debt ratios for several leading economies. During the "great moderation" (1992 – 2008) governments experienced temporary improvement in public finances, leading to overoptimistic projections and loosening of the fiscal policy stance. The access to the foreign markets combined with economic recession contributed to the accumulation of external debt in European countries. As a result, the EU total deficit has increased sharply from 1% of GDP in 2007 to 6.8% of GDP in 2009, and turning back to 1.7% of GDP in 2016 (Arroyo, 2011). However, in many EU Member States gross national debt levels are still close to 100% of GDP, and in some countries have even exceeded this level[1]. Ageing populations, expected increases in health care costs and sluggish economic growth add urgency to this worrisome trend. According to the European Commission Ageing report the old-age dependency ratio is projected to rise from 27.8 percent in 2015 to 46.1 percent by 2040 (EC, 2015). Under such circumstances any rising debt will ultimately prove unsustainable.

1 According to 2016 European Comission report 16 EU Member States reported a debt ratio above 60% of GDP at the end of the year: the highest level registered was 179.0% for Greece, followed by 132.6% for Italy, 130.4% for Portugal, 107.8% Cyprus and 105.8% Belgium. The lowest levels of debt-to-GDP ratios were 9.5% for Estonia, 20.0 % for Luxembourg and 29.5% for Bulgaria.

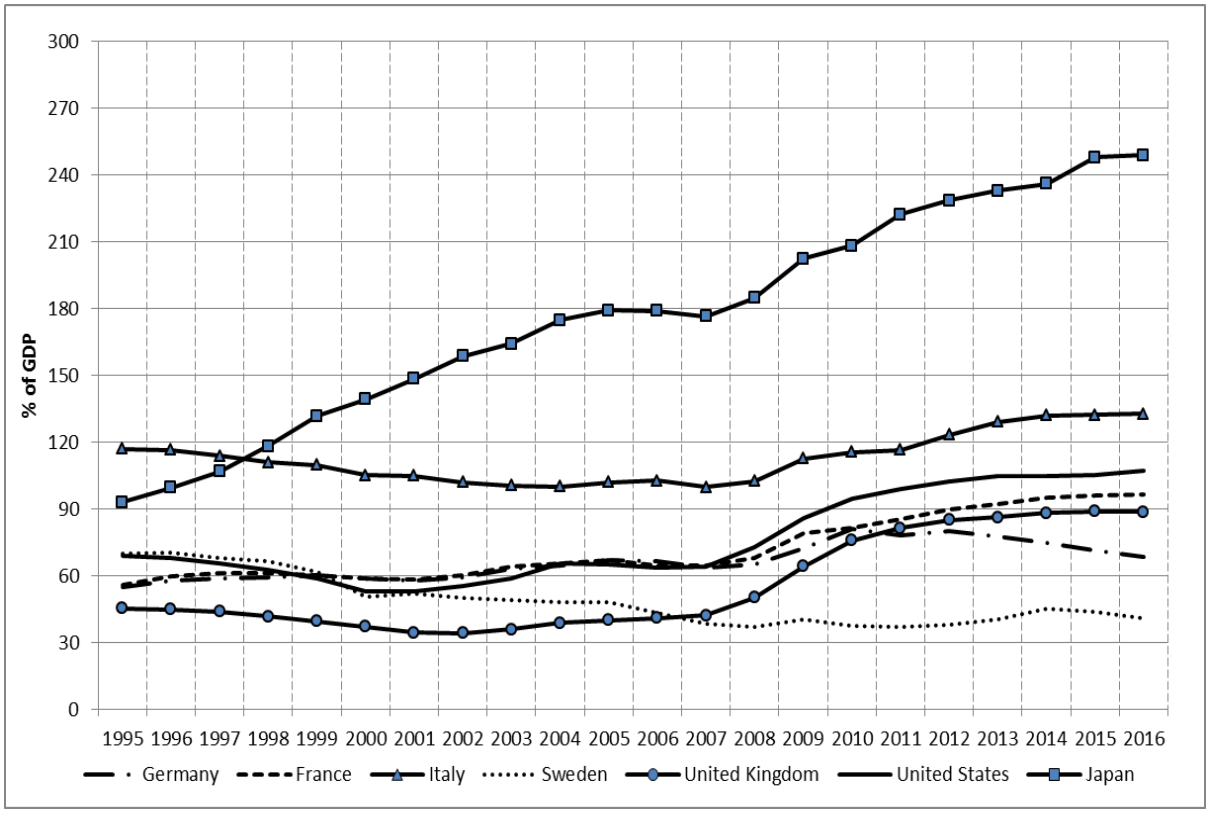

Fig. 1. Trends in public debts ratios in leading economies, 1995-2016

Source: European Commission AMECO database.

Macroeconomists ignored this issue for a long time due to the fiscal theory of money (Canzoneri, et al. (2001), Marimon (2001)). The main idea is that as long as the Central Bank achieves low and stable inflation by influencing interest rates in the money market, government does not have to pay much attention to fiscal balances. Since 2008, the ECB interest rate has reached a zero level, so lowering it further to produce more stimulus has no longer been an option. Consequently, the ECB relied on unconventional policy tools such as large-scale asset purchases. However, an ultra-loose policy as a way of getting out from debt overhang can only ultimately help to increase private credit. In addition, the transmission mechanism remains unclear and might have various adverse effects[2].

A potential solution to these challenges would involve an aggressive fiscal consolidation and adoption of tax increases. These factors pose a serious challenge to

[2] For detailed discussion see Chen, Cúrdia, and Ferrero (2012) and Gambacorta, Hofmann and Peersman (2012).

the policymakers who have to make hard choices in setting fiscal policies that are responsible and realistic about the expenditure and tax levels appropriate to the country's needs (Auerbach, 2017). Thus, detailed sustainability analysis is needed to achieve a feasible solution to the problems of fiscal imbalances.

The economic literature on sustainability analysis and debt management has been expanding rapidly and distinguishes between two methods. First, non-stationary time series analysis, focused on the stochastic properties of the deficit inclusive of interest payments (Hamilton and Flavin, 1986) or the stock of debt (Wilcox, 1989). Estimation results imply that policy-makers in most EU countries have failed to keep fiscal discipline and balanced budgets. Alternative approach is focused on the long-run cointegrating relationship of expenditure and revenues (Trehan and Walsh (1988); Quintos (1995); Prohl and Schneider (2006); Berenguer-Rico and Carrion-i-Silvestere (2011)). These studies concluded that the intertemporal budget constraint in European countries was overall complied. The lack of consensus between these approaches has motivated a further line of research that finds stronger evidence in favor of stationarity, cointegration and sustainability when allowance is made for the existence of structural breaks or non-linearities in the deficit series (see, Quintos (1995); Ricciuti (2003); Considine and Gallagher (2008); Chortareas, Kapetanios, and Uctum (2008)).

The second strand of economic literature treats fiscal sustainability problem by means of fiscal policy reaction function (FPRF). It estimates the degree of the reaction of primary balance to changes in debt. However, not much consensus exists in the literature on the actual degree of anti-cyclical policy or consolidation in response to the debt ratio that euro area governments have historically pursued. Time-series estimates of a fiscal policy reaction function for the euro area in levels have generally indicated a weak degree of anti-cyclical policy, while estimates of a fiscal policy reaction function in first differences have indicated a stronger degree of anti-cyclical policy, more in line with results from the cyclical adjustment literature (Plödt and Reicher, 2014).

Taking into consideration the above-mentioned results, we also want to stress a few shortcomings in the empirical literature, which offer room for further research and improvements. First of all, while trying to construct a robust fiscal policy reaction function with the strongest predictive power researchers usually try to use data from

countries where it is of the biggest length and highest quality, i.e. developed countries from G7 or EU 14 groups (Hamilton and Flavin, 1986; Quintos, 1995; Afonso, 2005; Bohn, 2008; Holmes, Otero and Panagiotidis, 2009; Camarero and Carrion-i-Silvestre and Tamarit, 2013). Transition countries like the ones from the CEE group have been often omitted due to data availability issues. However, it has been shown that emerging economies have lower tolerance for sovereign debt, with defaults at much lower levels of public debt to GDP (Reinhart, Savastano and Rogoff, 2003)[3]. In addition, comparing to developed countries like Portugal and Greece, which stuck with the high debt levels, CEE economies are not yet affected with the "debt tumor". So, they can cure a disease in the early stage and become the source of economic growth of the EU. Thus, more emphasis should be put on the developing EU countries when conducting the sustainability analysis.

The next issue is that most papers use the data that stops before the sovereign debt crisis. Most of the studies cover the period between 1995 and 2008, consequently they don't consider all the countries that exceeded the fiscal fatigue thresholds. Finally, countries' heterogeneities are not thoroughly looked at. Just as economies of developed and developing countries run in pretty different ways, so the banking distress periods differ in each of the country groups, which is reflected in their fiscal reaction functions. These differences are crucial because reduced reaction at high debt levels might be caused by heavily indebted countries that historically had weaker response to debt accumulation. This also explains why these countries are heavily indebted.

Following the discussed motivation the aim of our research is to examine the sustainability of public finances in the group of Central and Eastern European countries by applying recent advances in non-stationary panel data methods and fiscal policy reaction function. Previous literature suggests that fiscal policy of Central and Eastern European faced various challenges during these decades[4]. Thus, we want to answer the question: does fiscal policy of the CEE countries lead to sustainable economic growth?

[3] According to the IMF (2003), public debt was below 60% of GDP in every second sovereign default case recorded in emerging market economies in the past.

[4] Afonso, Nickel and Rother (2005) report that debt-to-GDP ratio in CEE countries was below the advanced European economies level, however was increasing at a much higher rate. Mihaljek (2009) showed that CEE countries financed their long expansion to a great extent by borrowing from foreign markets and given the scarcity of external sources of funding in the latest years, fiscal consolidation is strongly needed.

We break the question into two parts: i) what is the policy reaction to the debt increase; ii) is the fiscal policy countercyclical.

Regarding the time span and countries comprised, our work is closely connected to Eller and Urvova (2012), Baldi and Staehr (2012) and more recently Krajewski, Mackiewicz & Szymańska (2016), who estimate the fiscal reaction function for a panel of Central Eastern and Southeastern European countries. However, we extend our analysis by considering the most recent data available (1995-2015). In order to reconcile differences in the previous results, we carefully investigate the order of integration of main fiscal variables employing unit root tests that allow for structural breaks. On the next step we use follow the baseline case of Ghosh et. al. (2013) and estimate fiscal reaction functions with a set of different control variables to better understand the fiscal policy behaviour.

Our results show that the primary balance in CEE countries is less persistent than in the developed ones. It appears to be extra reactive to increasing public debt (in a corrective manner) and to business cycle fluctuations (in a countercyclical manner) in line with the recent literature implying fiscal sustainability in CEE countries. After the crisis in 2008 the fiscal response gets even more reactive to the debt, however, turning its behavior to acyclical. Next, we find evidence of the "fiscal fatigue" (positive but eventually slowing response of the primary balance to rising debt) during the crisis and post-crisis periods. We also come to a conclusion that unconventional monetary policy of the ECB harms fiscal discipline, which is reflected in the positive effect of the shadow policy rate on the primary balance. Finally, the change in fiscal response to interest payments, old dependency ratio and fiscal rule index variables points out the shift in priorities of the fiscal authorities as an aftermath of the crisis.

Overall, our research contributes to the literature in the following ways: i) we consider both non-stationary time-series analysis with estimation parameters of fiscal reaction function for completeness and robustness purposes; ii) we take a longer time span and make use of uniform and comparable data; iii) in line with recent literature we test the hypothesis of "fiscal fatigue" in CEE economies; iv) finally, we experiment with several specifications of the fiscal reaction function to test related economic hypotheses.

The rest of the paper is organised as follows: Section 2 provides a brief review of the literature our research is built on. Section 3 discusses the alternative strategies for testing sustainability and econometric issues involved in estimating fiscal reaction functions. Section 4 describes the data used in the article and conducts stationarity analysis of the main fiscal variables. Section 5 reports the results of the fiscal reaction function of CEE countries. Finally, Section 6 concludes and discusses possible ways to improve the research.

2. Literature Review

2.1. Fiscal sustainability indicators (FSI)

Sustainability issue was brought into the nutshell, during the early 80s, following the oil crisis in 1970. Huge budget deficits almost doubled public debt in OECD countries, which jumped from 28 percent of GDP in 1960 to 50 percent in 1980. The result was a very extensive theoretical and empirical literature emerged on this topic (Hamilton and Flavin (1986), Trehan and Walsh (1988), Blanchard et al. (1990), Ahmed and Rogers (1995)).

Early findings ended up with a series of fiscal sustainability indicators. The most common measures of government solvency were the primary gap and tax gap. The gap is defined as the difference between the current and some sustainable level of the primary deficit or the tax ratio[5]. Sustainable level was defined as one that ensures convergence of the debt ratio towards a finite value. A primary goal of sustainability indicators is signalling about excessive debt accumulation. They show how painful the adjustment would need to be to stabilise the debt. The major advantage of sustainability indicators is simplicity. That's why they are often used for setting up fiscal targets and adapting public finances to future spending pressures such as those resulting from population ageing. However, there is a significant gap between the theory and the measures that policy makers use in practice for decision making (Krejdl, 2006).

Chalk and Hemming (2000) argue that the benchmarks based on sustainability indicators rest on bias assessments and create the wrong incentives for urgent

[5] For further details refer to Buiter (1985) and Blanchard et al. (1990)

adjustments and divert attention from alternative policy options, which would emphasize sustained growth. For instance, a positive fiscal gap neither means that the country's solvency is in danger, nor that adjustment is needed. This discrepancy has a considerable impact on the policy recommendations that follow from different assessments of fiscal sustainability. Moreover, indicators rest on assumptions about the maximum level of primary surpluses (debt). The main inputs for its calculation, interest and growth rates can change abruptly due to exogenous shocks. So, a debt level that appears sustainable under one set of assumptions might be insolvent if interest rates surge or the growth rate plunges (Barta, 2015).

2.2. Non-stationary time series analysis

Another scope of economic literature treats fiscal sustainability problem by the means of non-stationary time series. It deals both with the difficulty in forecasting interest and growth rates and with the uncertainty of the maximum level of primary surpluses. Evidence against unit roots has been considered to support the strong form of sustainability consistent with the intertemporal budget constraint (Holmes, Otero, Panagiotidis, 2010). In practice, however, fiscal variables are rarely stationary in level. Single country analysis performed on debt series reports contradicting results. Trehan and Walsh (1988) find that the budget deficit in the United States follows a stationary stochastic process, while Wilcox (1989), Hamilton and Flavin (1986), and Hakkio and Rush (1991) fail to find evidence that the budget deficit in the US is stationary implying an unsustainable budgetary process.

Another way to address this problem, proposed by Quintos (1995), Ahmed and Rogers (1995), is to explore the structural relationship between government expenditures and revenues. The existence of a cointegrating relationship has been considered as evidence consistent with the IBC and can be regarded as the “weak” form of budget sustainability (Holmes, Otero, Panagiotidis, 2010). However, researchers once again end up with puzzling and inconsistent results.

Economists have tried to improve the robustness of short time series tests by applying panel data technique. Modern panel analyses of cointegration and stationarity have been implemented by Afonso and Rault (2010, 2015), Prohl and Schneider (2006), Holmes,

Otero and Panagiotidis (2009), Westerlund and Prohl (2010) and Camarero and Carrion-i-Silvestre and Tamarit (2013). Afonso and Rault (2007) emphasize that the main advantage of panel cointegration analysis is that it increases the power of the tests by including new observations from individual time series. In addition, cross-section information reduces the probability of a spurious regression.

Unit root tests applied to panels can be divided in three groups: (i) first generation tests assuming cross-country independence among panel units except for common time effects (Maddala and Wu (1999); Levin, Lin, Chu (2002); Im, Pesaran, Shin (2003); Pesaran (2007); (ii) second generation panel unit root tests allowing for cross-country dependence (Moon and Perron (2004); Choi (2006)); (iii) panel unit root test allowing for structural breaks (Im, Lee, 2001) based on the Lagrange multiplier.

In most cases panel tests consider a joint null hypothesis of a unit root against the alternative of at least one stationary series in the panel. However, Im, Pesaran and Shin (2003) point out that one needs to be very careful interpreting the results. For example, in the case of mixed panel, when only some of the members are stationary, researchers often draw a much stronger conclusion about government debt series. The most that can be inferred is that at least one country is mean reverting or that stationarity holds only marginally for a few countries.

Next point which received significant attention in empirical literature is the problem of structural breaks. Afonso and Rault (2007) and Chortareas, Kapetanios, and Uctum, (2008) show that combining structural breaks with panel data allows to improve the power of the unit root tests significantly. However, many economists argue that there is little evidence that a structural break, if present, occurred in all countries at the same time. Hence, there is more sense to study structural breaks on the individual level.

The main shortcoming of the panel unit root tests is that they typically require relatively long time series that are rarely available. Application of short time span could partly explain inconclusive results of early studies. Afonso (2005) illustrates the small sample problem for a comprehensive set of countries based on cointegration tests. Additionally, unit root tests perform poorly, when fiscal policy is on the "border". In practice many variables or their combinations are borderline cases, so that distinguishing between a

strongly autoregressive I(0) or I(1) process (interest rates are a typical example), or between a strongly autoregressive I(1) or I(2) process is far from easy (Afonso, Rault, 2007). Next, the empirical conclusions stemming from the analysis of a heterogeneous group of countries are vague and often have little economic content. In this respect Afonso and Jalles (2008) note that if we wrongly assume cross-sectional independence among the units in the panel then the null hypothesis of panel stationarity is clearly rejected. Finally, argued by Bohn (1998, 2008), the basic time series test does not fully exploit uncertainty around fiscal sustainability. Applied to the US debt series during 1916-1995, Bohn showed that conventional univariate analysis fails to reject sustainability hypothesis. As later would be emphasized stationarity of public debt is only a sufficient condition in assessment of fiscal sustainability. Bohn claims that a better solution would be to analyze the government's reaction to changes in public debt, e.g. reducing the deficit or increasing the surplus. This approach is often referred as the fiscal policy reaction function.

Despite the big skepticism around conventional unit root tests, one must note that order of integration of fiscal series still plays a crucial role in sustainability analysis. It defines how fast country will fulfil the IBC condition (Quintos, 1995). A high order of integration is associated with higher macroeconomic risks of insolvency. From a technical point of view, the assessment of order of integration is required in order to build more complicated time series model.

2.3. Fiscal policy reaction function

The rest of studies are built on the framework of fiscal reaction functions proposed by Bohn (1998). The main purpose of FPRF is to describe the automatic and discretionary reaction of the fiscal authorities to debt accumulation. The idea behind the FPRF is that the fiscal policy is sustainable as long as the primary surplus reacts sufficiently strongly to changes in debt to make sure that debt growth is bounded in the long run (Bohn 1998, 2008).

The fiscal policy reaction function is considered as a more flexible approach to assessing fiscal sustainability. Unlike conventional unit root tests, it gives insights into the magnitude and the lag of the government's reaction to public debt shocks. Fiscal

reaction function reveals the government's ability to generate a primary surplus in the short term in order to meet the constraints imposed by the IBC in the long run (Stoian and Campeanu, 2010). This condition is usually tested by estimating a regression of primary balance on lagged debt series. In case of a linear relationship, a positive and statistically significant debt coefficient would mean that country is committed to reduce or maintain steady debt-to-GDP ratios conditional on a set of other factors (Checherita-Westphal and Ždarek, 2017). Previous literature finds that in advanced economies governments usually meet fiscal sustainability constraints. The coefficient of the debt-to-GDP ratio is commonly between 0.01 and 0.10 (Table 1). This means that a marginal increase in gross government debt (1 p.p.) leads to approximately 0.01 - 0.1 p.p. fiscal tightening in primary balance in the next year. For a detailed review of FPRF literature see Table 2.1 in Appendix 2.

Recent fiscal policy reaction research has focused on the studying of nonlinear behavior of the debt dynamics. In this context, the hypothesis of fiscal fatigue has been tested. Generally, studies applied to large panels of advanced economies point the presence of so-called "fiscal fatigue". This phenomenon means that at very high level of the debt ratio, the fiscal effort becomes too large to increase with the same speed (Ghosh et al, 2011,2013; Everaert and Jansen, 2017). For instance, Ghosh et al. (2013) provide evidence of fiscal fatigue by considering the cubic specification of FPRF for a group of 23 advanced economies over the period 1970–2007. The results of estimations suggest that the responsiveness of fiscal policy starts to decrease at the debt level of 90-100% of GDP and becomes negative when the debt level approaches the threshold of 150% of GDP.[6] The authors explain the phenomenon of "fiscal fatigue" by the disability of the government to increase primary balances with the same pace as the debt goes up.

[6] This conclusion is contrary to the results of Bohn (1998) according to which the fiscal reaction increases with increasing debt.

Table 1. Summary of fiscal policy reaction function literature

Study	Sample	Estimate of debt coef.	Study	Sample	Estimate of debt coef.
Bohn (1998)	US ,1916-1995	0.054	Afonso and Jalles (2011)	18 OECD, 1970–2010	-0.05–0.17
Debrun and Wyplosz (1999)	EU-11, 1982–1997	0.01-0.03	EC (2011)	EU-27, 1975/1980–2010	0.033 – 0.038
Galí and Perotti (2003)	EU-11 and OECD-5 1980–2002	-0.07 (EU-11) -0.02 (OECD5)	Ghosh et al. (2011)	23 DMs, 1970/1985–2007	-0.2080
IMF (2003)	54 EMs and DMs, 1990–2002	0.039–0.047	Eller and Urvová (2012)	EU-8, 1995–2011	0.026–0.060
IMF (2004)	EA-12, 1971–2003	0-0.08	Escolano et al. (2012)	EU-27, 1990–2008	0.0367
Abiad and Baig (2005)	34 EMs, 1990–2002	0.048–0.072	Medeiros (2012)	EU-27/-21, 1976–2011	0.054–0.078
Abiad and Ostry (2005)	31 EMs, 1990–2002	0.04–0.06	Theofilakou, Stournaras (2012)	10 EA, 1988–2009	0.0240–0.0426;
Annett (2006)	EU-14 ,1980–2004	0.01–0.03	Betty and Shiamptanis (2013)	11 EA, 1970–2011, pre-EMU (1970–1998) and post-EMU (1999-2011)	0.0727
Celasun et al. (2006)	34 EMs,1990–2004	0.030–0.046	Debrun and Kinda (2013)	28 EMs and 26 DMs, 1980–2010	0.032–0.037
Golinelli and Momigliano (2006)	19 OECD, 1988–2006	0.008–0.024	Ghosh et al. (2013)	23 DMs, 1970/1985–2007	-0.208– -0.225
Ayuso-i-Casals et al. (2007)	EU-22, 1990–2005	-0.18– -0.02	Legrenzi and Milas (2013)	Greece, Ireland, Portugal and Spain, 1960(1970)–2012	0.087–0.177
Bohn (2008)	US,1792–2003	0.094 – 0.121	Cuerpo (2014)	Spain, 1986q1–2012q4	-0.032 – 0.018
Debrun et al. (2008)	EU-25, 1990–2005	0.02-0.04	Debrun and Kinda (2014)	28 EMs and 26 DMs, 1990–2011	0.015–0.023
Golinelli and Momigliano (2008)	11 EA, 1978–2006	0.009–0.014	Schoder (2014)	15 OECD, 1981–2010	0.041 (1980–1996) 0.011 (1997–2010)
Mendoza and Ostry (2008)	22 DMs and 34 EMs 1980/1990–2005	0.033–0.072	Weichenrieder and Zimmer (2014)	EA, 1970–2011	0.043-0.059

* EM – Emerging Markets, DM – Developed Markets, EU –European Union, EA – Euro Area, OECD – Organisation for Economic Co-operation and Development.
Source: Checherita-Westphal and Žďarek (2017)

Medeiros (2012) reports similar results for EU countries, with fiscal fatigue thresholds between 80 and 90% of GDP. On the other hand, EC (2011) tests for non-linear debt effects (quadratic and cubic terms) on cyclicaly adjusted primary balance for a panel of EU countries over the period 1975/1980 – 2010 and does not find significant supporting evidence.

There is little evidence on the fiscal sustainability of emerging Euro area countries mainly due to limited data. Abiad and Ostry (2005) was among the first studies, which explicitly focused on the emerging EU countries. The authors emphasize that along with the advanced countries, the increase above the threshold levels of the debt diminishes the responsiveness to debt in emerging market countries. In fact, the authors argue that the ability of policy makers to maintain fiscal solvency through higher primary balances with debt ratios above 50-60 % range appears to wane.

Mendoza and Ostry (2008) study how the degree of fiscal policy responsiveness varies between industrial and emerging market countries. Obtained estimates of debt parameter are 0.02 for advanced economies and 0.036 for both emerging economies and the combined panel. As Mendoza and Ostry (2008) concluded, this higher debt coefficient is not an indicator of "more sustainable" fiscal policies in emerging economies, but a simple evidence that past increases in debt of a given magnitude in these countries require a stronger conditional response of the primary balance, and hence less reliance on debt markets, than in advanced economies. In contrast to the previous studies, Mendoza and Ostry didn't find that the responsiveness to debt increases, when the debt exceeds threshold levels in panel of advanced countries, but it does diminish for emerging market economies.

The recent study of Baldi and Staehr (2013) considers the differences in fiscal reaction of developed and developing European countries. Overall, the primary balance in both groups shows the same persistence and cyclical reaction, however the responsiveness to debt ratio was much higher in advanced Northern European states. The authors relate reduced reaction of CEE economies to debt accumulation to generally low public debt.

Finally, the most recently Krajewski, Mackiewicz and Szymańska (2016) together with Eller and Urvová (2012) found evidence that primary balance in the CESEE countries under consideration is highly persistent and responds in a corrective manner to increasing public debt and in a countercyclical manner to business cycle fluctuations (in line with Staehr, 2008). Moreover Krajewski, Mackiewicz and Szymańska (2016) found evidence of non-linear relationship between primary balance and lagged debt, with fiscal fatigue occurrence at the 70% threshold. Eventually, they provide evidence that response of primary balance to lagged debt and output gap is not homogenous across

countries and time period in the sample, as well as that it also depends on the exchange rate regime.

Additionally, fiscal policy reaction literature studies the response of the fiscal policy to the GDP fluctuations. The usual finding is that in the emerging economies, fiscal policy is procyclical or neutral. IMF (2015) states that developing countries are characterized by asymmetry in the fiscal policy response to the business cycle meaning that during recessions the policy is countercyclical while during the economic growth – procyclical. Symmetrycal reaction to business cycle is important for three following reasons: (i) building buffers to sustain cyclical downturns; (ii) decreasing the risk of overheating; (iii) and avoiding debt accumulation over successive cycles. For emerging markets, good times often mean easier access to financing providing an opportunity to satisfy the key priorities of economic growth and poverty reduction. Thus, the asymmetric response of fiscal policy throughout the economic cycle bears threats to the debt sustainability (Vdovychenko, 2016).

3. Methodology

In this section we derive the baseline fiscal reaction function used in our analysis. We start by looking at the different functional forms used in the literature to describe the relationship between the primary balance and government debt. Finally, we end the section by considering the econometric issues of estimating fiscal policy reaction functions using panel data technique, in particular, endogeneity of lagged debt and the output gap to the unobserved shocks to the primary surplus.

3.1. Alternative strategies of testing sustainability

We start with the conventional baseline linear model of Bohn (1998, 2008):

$$S_t = \alpha + \rho b_{t-1} + \delta X_t \qquad (1)$$

where S_t – primary budget balance to nominal GDP ratio, b_{t-1}– public debt to nominal GDP ratio, X_t – a vector of control variables, which typically include proxies for temporary fluctuations in output and government expenditures, and ε_t is an iid error

term. In case of a linear relationship a positive and significant debt coefficient ($\beta > 0$) would mean that government commits to reduce or maintain steady debt-to-GDP ratios.

While the basic specification of FPRFs is relatively straightforward, a great attention has been put in the literature on accurately specifying the possible differences in reaction of the primary balance at different debt levels. Initially specified as simple linear functions of debt, FPRF has been frequently estimated using nonlinear specifications, either by including exogenous debt thresholds (Lukkezen and Rojas-Romagosa, 2013, 2012; Celasun et al, 2007) or by using polynomial functions (either quadratic or cubic; Gosh et al, 2013, 2011; Medeiros, 2012; Bohn, 2005). For instance, Ghosh et al. (2013) suggested following non-linear debt function:

$$pb_t = \alpha + \beta_1 d_{t-1} + \beta_2 {d^2}_{t-1} + \beta_3 {d^3}_{t-1} + \delta X_t + \varepsilon_t \qquad (2)$$

Such specification aim to capture threshold level, beyond which fiscal responsiveness would increase (lower bound) or decrease (upper bound). The positive, but eventually slowing response ($\beta_3 < 0$ or $\beta_2 < 0$ and $\beta_3 = 0$) of the primary balance to rising debt corresponds to the issue of "fiscal fatigue" in budgetary adjustment process, i.e. at high levels of public debt government tends to increase primary balance more slowly in order to preserve debt sustainability.

Similar to Ghosh et al. (2013) and other recent works, our empirical model also explores nonlinearites in government debt – primary balance relation:

$$pb_{it} = \alpha_i + \varphi pb_{it-1} + \rho d_{i,t-1} + \beta d_{i,t-1}^2 + \gamma gap_{it} + \delta \mathrm{X}_{it} + v_{it} + \varepsilon_{it}, \qquad (3)$$

where pb_{it} is the variable measuring primary balance in terms of GDP, $d_{i,t-1}$ is the lagged debt-to-GDP ratio, φ is the regression coefficient for the lagged dependent variable (primary balance) and X_{it} is a vector containing various (macro)economic, institutional and political determinants of primary balance, v_{it} are country fixed effects and ε_{it} is the error term. The highly politicized nature of government budgeting makes it hard to react immediately to changes in debt and other economic conditions. To allow for sluggishness in the response of fiscal policy, we add the lagged primary balance $pb_{i,t-1}$ to the explanatory variables.

3.2. Model specification

For the dependent variable one of the two main policy variables are used in the literature: cyclical adjusted primary balance (CAPB) and primary balance. The former is used to estimate pure "fiscal effort", while the latter is more related to the output gap and shows the overall fiscal policy behavior. We choose primary balance as a dependent variable in our model, since it is the "observable" fiscal policy variable, it is less prone to ex-post revisions, and it is used in most previous studies (Checherita-Westphal and Žďárek, 2017).

Along with the study of statistical characteristics of debt and budget parameters, a number of control variables were included to the FPRF to test additional hypotheses. Previous literature considers control variables of economic (like oil prices, CPI inflation, openness) and institutional nature (like index of institutional quality, commitment to IMF programs, fiscal rules index, election indicators).

Given that the GDP gap contains information on prices and economic growth, this measure is often introduced into FPRF in order to take into account the output stabilization (Favero and Monacelli, 2005; Clayes, 2008). If the primary balance was related positively to the output gap, favorable economic developments would improve the budgetary position of a country (e.g. via boom-induced revenue windfalls) – indicating a countercyclical fiscal response. By contrast, a negative coefficient would indicate a procyclical, and an insignificant coefficient an acyclical fiscal response.

Output stabilisation is usually seen as a more important goal of fiscal policy for countries in a monetary union, where it is the only tool available to deal with country-specific shocks. However, the lifetime budget constraint can be satisfied not only by means of fiscal instruments, but also by generating a lot of seigniorage revenue. That is why the monetary indicators, like the interest rate, inflation or the income from seigniorage are also often included into the FPRF to account for the impact of the monetary policy (Budina and Wijnbergen, 2008).

Another important variable frequently included in FPRF is the current account (CA). The reasoning is related to the twin-deficit hypothesis which states that a fiscal deficit (due to e.g. a tax reduction) may lead to an income boost and hence a current account

deterioration. Including CA variable in the fiscal reaction function researchers usually simultaneously test the twin-deficit hypothesis with their model (Checherita-Westphal and Ždarek, 2017).

Recent developments in the EU related to the financial and sovereign debt crisis call for additionally controlling for some other factors. The intensity of the crisis has affected the relationship between public revenues (and spending) and GDP, with a strong increase in short-term fiscal multipliers. In order to catch the financial distress effect on the fiscal policy, a crisis dummy is usually introduced in the specification. Several papers use more recent data to investigate the issue of whether governments' primary balances have become more responsive to debt since the onset of the 2008 financial crisis (Baldi and Staehr, 2015; Checherita-Westphal and Ždarek, 2015).

The next variable of interest is the interest payments to GDP ratio. Debrun and Kinda (2013) found that a higher share of government revenue absorbed by interest payments tends to trigger a positive response of the primary balance beyond what is needed to achieve solvency, which they call the 'squeezing feeling'. The intuition is that governments set a specific target in terms of the debt-to-GDP ratio, forcing the actual primary balance to move synchronously with its debt-stabilizing level. Another interpretation is that even being subject to extreme myopia, optimizing governments don't tolerate the crowding-out of socially useful expenditure by rising debt service.

As many countries incorporated some variants of fiscal rules in their policy it's also useful to investigate their effect on the primary balance. Tkačevs and Vilerts (2016) in their paper make use of the fiscal rule index (FRI) developed by Maltritz and Wuste (2015) to check the response of the fiscal policy to the degree of regulations followed. The intuition is that the stronger regulations usually help to keep the budget balanced leading to the debt sustainability. On the other side, overregulation could harm during the times when quick and flexible actions are required, such as during the crisis.

Another issue often discussed together with the budget balancing is implicit budget liabilities. Countries with a higher proportion of the old age population should account for it in their budget by saving more funds to cover the liabilities to next generation

citizens. This relation is usually included in FPRFs in the form of the old age dependency ratio (Ghosh et al., 2011; Checherita-Westphal and Ždarek, 2017).

The theoretical and empirical literature suggests the significant effect of the political cycles on the fiscal policy outcome (Nordhaus, 1975, Alesina, Roubini and Cohen, 1997). The governments are willing to provide more expansionary fiscal policy in the pre-election time period. Its impact could be captured by including the election dummy variable into the FPRF specification.

Recent point of discussion is that ultra-loose monetary policy brought a noticeable increase in government borrowings, delaying the implementation of structural reforms. Tkačevs and Vilerts (2016) show that declining borrowing costs seem to affect budget behavior of fiscal policymakers by inducing them to run higher budget deficits. The authors report that this effect is particularly strong in the euro area countries, where interest rates has been significantly lower comparing to other countries. Hence, one point of interest would be to study the effect of the unconventional measures on the fiscal policy stance. Wu and Xia (2014) propose to measure the unconventional monetary policy with the shadow policy rate. It shows what the interest rate would be if it could go below zero.

We conclude the above discussion defining the final set of control variables for our FPRF:

- GDP gap as a proxy of the business cycle in line with most previous papers (Debrun and Kinda (2013), Westphal and Ždarek (2017), Tkacevs and Vilerts (2016));
- Harmonized Index of Consumer Prices (HICP) as an indicator of the monetary policy in line with Tkacevs and Vilerts (2016);
- CA as a reflection of the twin-deficit hypothesis in line with Checherita-Westphal and Ždarek (2017);
- Financial crisis dummy variable as a proxy for financial distress in line with Debrun and Kinda (2013). Following their approach we take the variable from Laeven and Valencia (2012) crisis database;
- Interest payments to GDP ratio as an indicator of the ‘squeezing feeling’ of fiscal authorities in line with Debrun and Kinda (2013);

- Old age dependency ratio as a reflection of implicit budget liabilities in line with Checherita-Westphal and Ždarek (2015);
- Fiscal rule index as a proxy of degree of fiscal regulations in line with Maltritz and Wuste (2015), Tkacevs and Vilerts (2016);
- Shadow policy rate as a proxy of the unconventional monetary policy in line with Wu and Xia (2017);
- Election dummy as an index of political cycle in line with Tkacevs and Vilerts (2016);

3.3. Econometric issues

Estimation of the fiscal reaction function encounters three possible issues: heterogeneity, time-variation and endogeneity. Ignoring these can lead to biased estimation of regression parameters if pooled estimators are used.

Fiscal reaction function relies on the implicit assumption that the coefficient ρ which respresents the effect of the lagged public debt on the primary balance (equation 3) is common across countries. This can be a strong assumption as the countries differ considerably in their ability to generate primary surpluses, history of their economic policies and the macroeconomic volatility they display. This issue is generally overcome by using fixed effects method of econometric estimation that includes a sole dummy variable for each country in the sample to capture country-specific effects v_{it}.

Global trends and common shocks can cause cross-sectional dependence and are potentially also a source of persistence. Serial correlation between $\varepsilon_{i,t-1}$ and $\varepsilon_{i,t}$ would result in a negative correlation between $d_{i,t-1}$ and $\varepsilon_{i,t}$. One of the possible options to account for these shocks is by considering time fixed effects. However, a set-up like this assumes the same effect of a shock on each country considered. This is a rather restrictive assumption. Probably a more reasonable solution is to include a lagged endogenous variable on the right-hand side of the fiscal reaction function in order to control for autocorrelation.

Medeiros (2012) points out three potential sources of endogeneity in the fiscal reaction function: (i) correlation of the output gap with the fiscal policy shock (a fiscal multiplier

effect), (ii) dependence of lagged debt on past values of the primary balance (a reverse causality issue) and (iii) persistence of errors, making lagged debt endogenous. The endogeneity of primary balance arises from the fact that past values of primary balance partly determine the current state of $pb_{i,t}$. Since the current debt-to-GDP ratio is determined by the lagged primary surpluses, pb_{it-1} at its turn determines $d_{i,t-1}$, which makes $d_{i,t-1}$ endogenous.

Persistence of errors is even more important in the case of panel data analysis, where a common fiscal reaction is assumed; in case of error correction model, where variables are considered in first differences, this source of endogeneity should be reduced – see Medeiros (2012). It results in a highly persistent primary balance as fiscal authorities can't react immediately to macroeconomic changes. Since the residuals are autocorrelated, countries with historically higher primary balances will have a lower debt ratio. Thus, the negative relation between debt and the errors will result in a downward bias of the estimated coefficient of debt. In order to address the bias, scientists allow for serial correlation in the error terms ($\varepsilon_{i,t+1} = \alpha\varepsilon_{it} + v_t$). Ostry et al., 2010 and Ghosh et al., 2013 deal with this issue by using the (iterated) Prais-Winsten Generalised Least Squares (GLS) estimator.

Previous research usually addresses potential endogeneity issues by applying proper instrumentation to the variables that are exogenous to the primary balance shocks. However, reliable instrumental variables (IV) based estimations require the use of suitable instruments that are strongly correlated with the endogenous regressors. Such ideal instruments are often not easy to find. Moreover, IV method might still result in the downward biased estimates of the debt coefficient.

One of the methods of consistent-estimation in dynamic panels is GMM of Arellano and Bond (1991) and Blundell and Bond (1998). It involves first-differencing equation (3) and using lagged levels of endogenous variables as instruments in a GMM regression. Blundell and Bond (1998) show that estimating a system that includes both the first-difference and the level equations and instruments endogenous variables with their lagged levels and first-differences greatly increases the efficiency of the estimations.

There are however some drawbacks to this approach. First, in the GMM setting, the minimal number of required instruments turns out to be large relative to the number of observations and can lead to over-fitting of the model. Roodman (2009) stressed that instrument proliferation can result in the overfitting of endogenous variables, fail to expunge their endogenous components and weaken the power of the Hansen instrument validity test (a telltale sign is the perfect Hansen p-value of 1.0). In addition, in case of weak instruments GMM estimator has weak properties in comparison with simple estimation methods. Finally, Judson and Owen (1999) and more recently Eller and Urvova (2012) provide arguments about the limited power of GMM estimator when the number of independent variables is large compared to the number of observations as in our case.

Considering all the flaws and complications of the two approaches discussed above we leave FE-IV and GMM for the robustness check. As the instruments we use the set of variables most commonly used in the literature. In particular, our set of instrumental variables includes second lag of debt, lagged output gap, lagged current account, trade-to-GDP ratio, US GDP growth rate, Russia GDP growth rate, oil price growth, non-fuel price, US short-term interest rate and potential GDP for each country. The validity of instruments is checked with the Sargan test.

We choose the FE estimator with GLS weights as our preferred option to obtain the estimates for equation (3). One drawback of this approach is the downward "Nickell's bias" that appears in samples where the time dimension T is small. However, Judson and Owen (1999) claim that the bias can be sizeable even when T = 20 (which is exactly the case of our sample). Furthermore, Blundell & Bond (1998) note that FE estimators perform better when the dependent variable is moderately persistent. As was stated in Roodman (2009), reliable estimates of the true parameter are in the "credible" range between pooled OLS and the panel fixed effects estimator. If one considers a 95% confidence interval around the estimates, the pooled OLS and the fixed effects estimator can't really be distinguished from each other. Consequently, at least in statistical terms, the bias due to endogeneity in our case should be limited. Finally, our panel is greater in the time dimension compared to the cross-section dimension, thus, limiting the potential bias.

4. Data

We examine the sustainability of the public debt and the budget deficit in the panel of 10 Central and Eastern European countries over the period 1995- 2016. The sample used in our analysis includes former transition countries and current European Union Member States: Bulgaria, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia, in the following referred collectively to as CEE-10.

All macroeconomic variables are taken in annual frequency and defined in relation to GDP. Even though there are examples of using higher frequency data in the literature, we follow the conventional approach based on annual data since fiscal data at a higher frequency is considered to be less meaningful. First of all, annual data matches well with the budget process. Secondly, quarterly data is rather noisy, include seasonal movements in economic activities.

The sources of the data are given in the Appendix 3, Table 3.1. The main source is European Commission AMECO annual database. As was noted by Afonso (2012, 2015) uniform methodology plays crucial role in panel analysis. It allows reliable cross country comparisons and consistency in the estimation results. Table 4.1 in Appendix 4 displays descriptive statistics for the fiscal series for CEE countries.

The assessment of the order of integration of the main fiscal series is important provided that this step is required in order to estimate robust fiscal reaction function that links them. The visual analysis of the data suggests that except for the debt ratio variables are close to a stationary process with transitive shocks (Appendix 4, Figure 4.1). The debt variable demonstrates non stationary behavior with the structural break in the 2008, after which we can observe not only a level shift but also a trend change. For deeper insight into the public finances in CEE countries, see Appendix 5.

Table 6.1-6.2 in Appendix 6 reports results of Dickey-Fuller (ADF) (1979) and Ng-Perron (NP) (1989) unit root tests supplemented by the Kwiatkowsky, Phillips, Schmidt and Shin (KPSS) (1992) stationarity test. For ADF test automatic lag length selection was used based on Akaike Information Criterion (AIC) with a maximum lag of 8. The

NP and KPSS tests are based on Newey-West automatic bandwidth selection and Bartlett kernel. All tests were conducted with the assumption of both trend and intercept stationarity.

Conventional unit root tests suggest that public debt series are non-stationary in the level. NP test reports presence of a unit root in debt series for all investigated countries. ADF and KPSS show that at the standard five percent level of significance only for Slovakia, suggesting its debt series are close to stationary processes. As for primary balance the presence of unit root has been rejected for five countries, namely Lithuania, Latvia, Poland, Slovakia and Slovenia, suggesting that they are stationary in the level.

As was pointed out by Perron (1989) and Lee and Strazicich (2003) conventional unit root tests can lead to misleading conclusions if the presence of structural breaks is ignored. The results would be heavily biased towards the non-rejection of a unit root. Thus, we proceed our analysis by computing the unit root test statistics in Zivot and Andrews (ZA) (1992)[7] .

The results of the break-point unit root tests, along with the estimated break points are reported in Tables 6.3-6.4 in Appendix 6. According to the results public debt series exhibited structural breaks with changes in the constant and trend. The unit root hypothesis can be rejected for seven countries, namely the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland and Romania. In most of the cases the break points appear in the 2008-2010, just after the global financial crisis, when a country faced problem with foreign borrowing. Concerning primary balance, the hypothesis of a unit root is rejected in almost all cases in favour of the stationarity of the fiscal balances (apart from Poland and Bulgaria). As in case of debt series the break points occur right after the financial crisis.

[7] The test is based on a regression equation with the assumption of two types of dummy variables. The variables are related to the mean shift occurring at each possible break-date and the shift occurring at trend. The null hypothesis of the test implies that the time series under consideration contains a unit root with a drift without any structural break. An alternative hypothesis of the test implies that analysed time series generates a trendstationary process with one time break that occurs at an unknown time.

The Zivot and Andrews (1992) test was further extended with Lumsdaine and Papell (LP) (1997)[8] unit root tests, allowing up to two breaks in trend and intercept. The results of the test are reported in Tables 6.3–6.4 in Appendix 6. By allowing for two structural breaks in primary balance it is possible to reject the unit root null hypothesis at the five percent level of significance for nine out of ten CEE countries (in line with Cuestas and Staehr (2013)). The exception is Lithuania. Debt to GDP ratio also turns out to be stationary, when we consider two structural breaks (except for the Czech Republic). In many cases the first break appears between 2000 and 2004, when the countries generally experienced rapid economic growth and extensive trade flows in anticipation of joining the EU, while the second structural break as before corresponds to the global financial crisis. Interestingly, we also see structural breaks in primary balance variables of CEE countries when the strong fiscal tightening took place in 2012-2013. Results oof panel unit root test presented in Table 7.1-7.2 in Appendix 7.

Overall, the individual unit root analysis presents evidence that the public debt and primary balance are stationary when structural breaks are incorporated, leading us to conclude that the solvency condition would be satisfied for CEE-10 countries. Moreover, as was pointed out by break point tests, the Great Recession in 2008 caused a significant structural change in the long run path of the fiscal series. In the further sections we also want to check whether the debt coefficient in fiscal policy reaction function has changed since the onset of the recent economic crisis. For this purpose, we estimate FPRF using two sub-periods: before (1995-2008) and after the crisis (2008-2015).

5. Results and discussion

The results are shown in the Table 2. We deal with period effect since the big scope of literature has documented the different response of primary balance to some variables over time. We estimate the basic specification for two sub-periods 1995-2008 and 2008-2015, in order to find how the recession has weakened the responsiveness of fiscal policy to the level of sovereign debt compared to the period prior to the crisis.

[8] The test is based on extended equation of the sequential trend break model of Zivot and Andrews (1992). If the null hypothesis of the Lumsdaine and Papell (1997) test is rejected, this means that the analysed time series is interpreted as a broken trend stationary with two breaks.

Tables 8.1-8.2 in Appendix 8 present the results for the two sub-periods. It's worth noting that obtained results have to be treated with caution, as we also lose a considerable number of degrees of freedom.

Our starting point is a benchmark regression which includes current account, lagged primary balance, lagged government debt to GDP ratio together with debt-to-GDP ratio squared output gap, HICP index and financial crisis dummy variable (see Table 1, column 1). Our results suggest that the lagged primary balance coefficient is positive and significant across various specifications in the full period sample and crisis sample, pointing to a robust persistency of the primary balance. However, contrary to the previous literature our model shows that the primary balance lacks persistence during the pre-crisis period. The coefficient estimate varies between 0.35 and 0.4 in the full period sample, implying that a 1 percentage point increase in the ratio of primary balance to GDP at t-1 will lead to a 0.35-0.4 percentage point (p.p.) increase in the ratio of primary balance to GDP at time t. This persistence might reflect the political nature of budgetary processes, which make the fiscal instrument to react gradually to its target (Claeys 2006). The coefficient estimate for the crisis sample shows slightly less persistence of 0.31-0.37.

As for lagged debt, it is insignificant in the pre-crisis period models, but turns to be highly significant in all the regressions for the crisis sample, showing that countries started to show some budget responsiveness after the crisis, tightening their budgets when their debt is on an increasing trend. One can notice that the debt coefficients in the crisis models (around 0.17) increased two or even three times compared to the ones in the pre-crisis (around 0.06) models. If debt-to-GDP ratio increases by 1 p. p. primary balance goes up by about 0.17 pp after controlling for other relevant factors.

Table 2. Fiscal policy reaction function: GLS coefficient estimates, CEE-10, 1995-2016

Dependent variable : pb_{it}						
	(1)	(2)	(3)	(4)	(5)	(6)
$pb_{i,t-1}$	**0.363*** (0.0716)**	**0.361*** (0.0706)**	**0.3436*** (0.0697)**	**0.3252*** (0.0654)**	**0.408*** (0.0611)**	**0.3568*** (0.0705)**
$d_{i,t-1}$	**0.0926*** (0.035)**	0.07 (0.04996)	**0.078** (0.0365)**	**0.0784** (0.0325)**	**0.0957** (0.0383)**	**0.0944*** (0.0345)**
$d^2{}_{i,t-1}$	-0.0002 (0.0004)	-7.87E-05 (0.0004)	-5.85E-05 (0.0004)	5.16E-05 (0.0003)	0.0006 (0.0005)	-0.0002 (0.0003)
gap_{it}	**0.2233*** (0.0411)**	**0.2375*** (0.0437)**	**0.2187*** (0.0389)**	**0.207*** (0.035)**	**0.2415*** (0.0343)**	**0.2234*** (0.0426)**
$hcpi_{it}$	**-0.0217*** (0.0086)**	-0.0092 (0.0156)	**-0.0426** (0.0194)**	**-0.0324*** (0.0116)**	0.0125 (0.0313)	**-0.0211** (0.0084)**
ca_{it}	-0.0081 (0.0284)	-0.01436 (0.0272)	-0.0155 (0.0268)	-0.02876 (0.0282)	-0.0219 (0.0157)	-0.0092 (0.0284)
int_{it}		0.4059 (0.3834)				
odr_{it}			0.221 (0.1586)			
fri_{it}				**0.4775** (0.2217)**		
ump					0.1984 (0.1828)	
$D^{elec}{}_{it}$						-0.2676 (0.2866)
$D^{fc}{}_{it}$	**2.629** (1.0577)**	**2.6894** (1.0699)**	**2.5318*** (0.8893)**	**2.5107*** (0.8693)**	**2.0764*** (0.5703)**	**2.5963** (1.098)**
Const	**-1.8301** (0.8039)**	**-3.0169*** (1.1471)**	**-4.964** (2.2417)**	-1.0736 (0.8352)	**-6.3833** (3.1284)**	**-1.8157** (0.8063)**
No. of observations	166	166	166	166	120	166
R-squared	0.6164	0.616	0.6181	0.6263	0.6748	0.6179
Durbin-Watson stat	1.8463	1.8487	1.8507	1.8612	2.091	1.8328
Redundant Fixed Effects Test	**4.7906*** **	**4.7688*** **	**3.5694*** **	**4.4845*** **	**5.6475*** **	**4.8285*** **

Note: The models include fixed effects dummies and are estimated using GLS cross-section weights and White cross-section coefficient-covariance method. Model 1 is the baseline model, while models 2 to 6 are extensions to the baseline. P-values are given in the parenthesis: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.

Lagged debt squared is statistically insignificant variable with negative sign of the coefficient estimated in the full, pre-crisis and some of crisis period sample models. However, for the most crisis period models it becomes marginally significant, which can represent some evidence of the "fiscal fatigue" issue in budgetary adjustment process in the recent years. Apparently, CEE countries start to show fiscal behavior similar to the one of advanced economies (where the responsiveness is stronger once debt surpassed some threshold as a percentage of GDP, see IMF, 2003), which is in contrary to previous research (Abiad and Ostry, 2005, or IMF, 2003).

Furthermore, in the pre-crisis and full period sample models fiscal policy appears to be extra reactive to cyclical developments. The coefficient estimate of the output gap remains positive and very significant in all specifications, with its magnitude remaining around 0.16 and 0.2 respectively. On the other hand, the coefficient becomes low and insignificant for the crisis period sample models. Thus, while the primary balance behaves in a countercyclical manner in the pre-crisis period (in line with the previous studies), it seems to turn to an acyclical behavior during the crisis. Since the full period sample shows even stronger evidence of the countercyclical behavior, our conclusion might be reasonably criticized in a way that the in-crisis period model results can't be trusted because their data sample is too short. However, we still consider it as a potential issue that needs some further research to be conducted on.

One should note that current account balance turns out to be insignificant in the model for the full period sample and significantly negative in the models for both partial period samples. This evidence underpins the previous studies that find that the twin deficit hypothesis fails for the CEE countries as opposed to developed countries. HICP has a negative effect on the primary balance in pre-crisis and full period sample models. The reason is that the higher inflation is expected to reduce the real value of accumulated debt, thus making policy-makers believe that they can increase budget deficit. During the crisis period, however, this relation turns to significantly positive meaning that being at a different stage of the business cycle affects the incentives of the authorities making them behave in the opposite way.

A surprising result is that the financial crisis dummy has a highly significant positive effect of around 2.6 on the primary balance meaning that during the crises the primary

balance is 2.6 pp higher than in the other periods. It's not consistent with the previous research. For instance, Debrun and Kinda (2013) use the same crisis dummy variable for a wider sample of emerging market countries and obtain coefficient estimates around -0.17. It means that this kind of relation pertains to the CEE countries only. The reasoning could be that the financial crisis is recorded only at the date when it happened, however, graphical analysis shows that this year still associates with solid budget surpluses, while the deterioration usually happens only afterwards. Thus, a conclusion can be made that financial distress affects primary balance of the CEE countries in a much slower way than it influences developed countries and some other emerging economies.

As regards other explanatory variables, higher interest payments seem to impact primary balance in a positive way during the pre-crisis period. In line with the "squeezing feeling" hypothesis of Debrun and Kinda (2013) our results show that fiscal authorities try to balance public expenditures and interest payments in order to sustain current debt burden. However, the relation between the interest payments and the primary balance is negative for the crisis period sample model meaning that CEE countries turn to ignore increasing interest payments. Together with the insignificant coefficient of interest payments in the full period sample model these results provide evidence that the "squeezing feeling" of the interest burden in CEE countries got distorted with the beginning of the Greate Recession.

The old age dependency ratio affects the primary balance in a significantly positive way during the pre-crisis period showing that countries with a higher proportion of the older population account for that when conducting fiscal policy by having a larger surplus. However, the coefficient becomes insignificant when estimating the model on the full period sample. Moreover, it changes its sign to negative in the crisis period sample model meaning that implicit budget liabilities related to the ageing population lose their priority in the crisis or post-crisis conditions.

The fiscal rule index has a significant positive effect on primary surplus in the pre-crisis and full period sample models. It's expected that better regulation of the fiscal policy would force authorities to tighten the budget in order to control debt levels. Again, the effect loses its significance and even turns to be negative if we estimate the model on

the crisis period sample only. The turn of the business cycle seems to distort the positive influence of the fiscal regulations on the fiscal policy. It can be reasoned that the tighter are the fiscal rules in a country the less flexible the decision-making process gets. That's why in the recessionnary conditions, when the authorities should react as soon as possible in a countercyclical manner, and eventually strict fiscal rules have to be ignored, the effect on the primary balance gets more severe in countries with less flexibility.

An interesting discussion could be held concerning the effect of the unconventional monetary policy measure. The shadow policy rate has no significant influence on the primary balance if we consider the full period sample, but it does seem to have a significant positive effect after the beginning of the crisis. It means that if the authorities use the quantitative easing reflected in decreasing shadow policy rate the primary balance goes down as well. It could be explained by a common view that the use of the unconventional monetary policies weakens fiscal discipline stimulating economic growth in a superficial way rather than implementing structural reforms.

Finally, the election variable remains negative but statistically insignificant through all the model specifications. It means that the primary deficit increases on the average during election year but the variability of this effect is too high to claim that it is strictly negative for the whole country sample. Consequently, the fiscal policy in CEE countries remains relatively free from the influence of politics.

Comparing our main results with the available results for developed countries one can notice that the primary balance persistence in our baseline model is lower than in those, 0.36 compared to around 0.5-0.7. The coefficient of the lagged debt in the pre-crisis period model is considerably higher than the one for the developed countries, 0.06 as opposed to around 0.02-0.03, and similar to the one for the developing countries, between 0.04 and 0.08, estimated in the literature. However, the one estimated in the crisis period model is around twice as large as those (0.17). Thus, the investigated sample of countries is more sensitive to the debt accumulation than the developed economies. As was noted before, there is some evidence on the 'fiscal fatigue' in the recent time meaning that CEE countries are starting to have fiscal behavior similar to the developed countries' one. The negative sign of the coefficients of the current

account and the positive one of the financial crisis variables strictly differentiate CEE sample from the developed countries showing the irrelevance of the twin deficit hypothesis and slow response of the fiscal policy to the financial distress.

We end the section by performing several robustness checks of the estimations. First, we've already dealt with period effect estimating the model over three sub-samples based on the stage of the business cycle, these are the pre-crises period, crisis period and full sample. Most of the coefficients stay consistent through the time frames and model specifications. Although some of the estimates shift dramatically, it was shown that there is a reasonable economic intuition behind these changes.

Table 3. Robustness checks with alternative estimators: FE, FE-IV and GMM

Dependent variable : pb_{it}			
	FE	FE IV	GMM
$pb_{i,t-1}$	**0.363*** (0.0716)**	**0.3874*** (0.0665)**	**0.2993** (0.0794)**
$d_{i,t-1}$	**0.0926*** (0.035)**	**0.08078*** (0.0374)**	**0.2564*** (0.0697)**
$d^2{}_{i,t-1}$	-0.0002 (0.0004)	-0.0002 (0.0004)	-0.0009 (0.0006)
gap_{it}	**0.2233*** (0.0411)**	**0.222*** (0.044)**	**0.128*** (0.0532)**
$hcpi_{it}$	**-0.0217*** (0.0086)**	-0.0104 (0.0101)	**-0.0241** (0.0115)**
ca_{it}	-0.0081 (0.0284)	-0.016 (0.0385)	**-0.1458*** (0.0522)**
$D^{fc}{}_{it}$	**2.629** (1.0577)**	1.8054 (1.1675)	**2.2511** (1.0344)**
Const	**-1.8301** (0.8039)**	**-2.3935** (1.087)**	
No. of observations	166	160	150
Durbin-Watson stat	1.8463		
Sargan test			**0.129**

Note: The FE model is the baseline model (Model 1 in Table 2) that uses fixed effects and GLS cross-section weights. FE-IV additionally uses instrumental variables and 2SLS. GMM is estimated based on differenced variables making use of instrumental variables and robust standard errors. Sargan test is based on the null hypothesis that the instruments are valid. Standard errors of the coefficients are given in parenthesis. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.

Next, we estimate the baseline models using alternative methods, FE-IV and GMM. The results are shown in the Table 3. The variables of the HICP and financial crisis variables become insignificant in the FE-IV model, while the coefficients for the lagged primary balance, lagged debt, lagged debt squared and GDP gap are almost identical to the baseline ones. In the GMM specification the coefficient of the lagged debt variable gets

much higher than in the baseline in line with our expectations discussed in the methodology section. On the other hand, the effects of lagged primary balance and GDP gap become considerably smaller while retaining their significance and the CA variable gains stronger negative effect and becomes highly significant making up for the sharp increase in the lagged debt coefficient. The effects of the HICP and financial crisis variables are close to the ones in the baseline. Thus, the size and significance of the main coefficients are consistent with the one in the baseline proving the stability of the baseline estimations.

The last type of robustness check is implemented across the country dimension. In this respect, we examine the issue of panel heterogeneity by running the benchmark specification dropping one country at a time. A single FPRF estimated over a panel of countries and a shorter time frame presupposes country-invariant fiscal behavior. We want to capture how the results would differ depending on the inclusion/exclusion of individual countries. Debt coefficients with their standard errors and significance levels from this procedure are summarized in Table 4. The exclusion of countries does not seem to alter the results significantly. Excluding highly indebted members seems to decrease the reaction coefficient of primary balance to debt only marginally.

Table 4. Fiscal reaction coefficient excluding individual countries

Country	**ρ-coef**	**Standart Error**
Bulgaria	**0.0665****	0.0276
Czech Republic	**0.0966****	0.0408
Estonia	**0.0929****	0.0366
Latvia	**0.1052****	0.0418
Lithuania	**0.0893*****	0.0319
Hungary	**0.1444*****	0.0357
Poland	**0.0934*****	0.0335
Romania	**0.0546***	0.0285
Slovenia	**0.0954*****	0.0341
Slovakia	**0.0895*****	0.0310

Note: The table shows the coefficient of the lagged debt and its standard error for the baseline specification of the model (model 1 in Table 2) with one country excluded at a time. P-value: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.

Hungary and Romania are outliers in the sense that the coefficients without Hungary are in most cases systematically larger and without Romania systematically smaller than in the baseline reflecting the fact that the debt ratio in both countries differs substantially from the average debt ratio in the CEE sample. Nonetheless, when we excluded both Hungary and Romania at the same time, the resulting coefficients still lay within the 95% confidence interval around the CEE estimates. For this reason, we believe that the investigated specification of the primary balance model is appropriate. Overall, the statistical significance and sign of the estimated coefficients remains unaffected by country exclusions.

6. Conclusions

This study makes use of the panel time series analysis and fiscal policy reaction function to assess sustainability of the fiscal policy in Central and Eastern European countries. So far, CEE have performed well in comparison to the developed European economies which was reflected in lower public debt-to-GDP ratios and economic growth exceeding the interest rate on public debt. Therefore, CEE governments were able to fulfil intertemporal budgetary constraint and to keep their fiscal policy out of the solvency risks. However, the increasing rate of public debt in the aftermath of the global financial and the sovereign debt crises poses a serious threat to fiscal sustainability.

First of all, let us turn to the stationarity testing, which is not the core part of the sustainability assessment, but a necessary step to characterize the responsiveness of fiscal policy to debt dynamics. At the national level, the hypothesis of sustainability of fiscal policy cannot be accepted for all countries. The break point unit root test indicates that fiscal authorities in CEE countries have maintained sustainable fiscal policies. These results were also further confirmed by panel estimation of the fiscal reaction function.

Moving further on to the question in the paper's title, we arrive at the following conclusions. Considering the time frame of 1995-2015 we come to conclusions that the primary balance in the CEE countries is less persistent compared to the one in developed countries and appears to be extra responsive to increasing public debt (in a corrective manner) and to business cycle fluctuations (in a countercyclical manner) in

line with the recent literature. Compared to elsewhere in the literature, our model suggests stronger estimates of the fiscal policy response to both lagged government debt and output gap, i.e. that any increase (decrease) of debt or output gap will increase (decrease) primary balance in the course of the adjustment process. Further, we allow for non-linear relationship between primary balance and lagged debt.

Although the validity of the results of the model estimated on the crisis sub-sample of 2007-2015 might be questioned, they still bring some important evidence. First, the response to the lagged debt gets twice as high as in the baseline model, while the quadratic debt term becomes significant meaning the presence of the 'fiscal fatigue' in the crisis period. Next, the response to the business cycle becomes acyclical, while reaction to variables of interest payments, old age dependency ratio and fiscal rule index change their signs, which says that with the beginning of the crisis the fiscal authorities suddenly change their behavior and ignore usual priorities. Finally, the primary balance surplus seems to deteriorate as a response to decreasing shadow policy rate, which could be considered as the evidence of a harmless effect of the unconventional monetary policy on the fiscal discipline.

One way to improve the research would be to use the so-called real time data estimating the fiscal policy reaction function. It was pointed out in the literature that reaction functions estimated based on ex post data can't accurately describe policymakers intentions, since this data doesn't correspond to the one available at that particular time. There is a possibility that even though policymakers seek to run countercyclical discretionary policy, they find it hard to do so in reality because of data limitations. In this case, fiscal policymakers are not malintentioned, but simply misinformed. Thus, the estimation of behavioral rules based on ex post data might mislead the researcher pointing to the wrong conclusions.

Furthermore, as discussed in the text, developing economies are often vulnerable to the issue of the asymmetry in the response of fiscal policy to the different phases of the business cycle. Our results show that there is a change in the fiscal behavior of the countries after the outbreak of the global financial crisis. That's why another extension to the model could be the incorporation of this asymmetry. It would help to investigate in more detail the shift in fiscal policy reaction.

We conclude our research with a discussion of the question about the sustainability of the CEE countries. Even though there is enough evidence to say that their fiscal policy is sustainable, we can't say that they are forever immune to the sustainability issues. Being solvent in the good times is not enough to assure a country from sudden structural changes leading to sustainability deterioration. The careful analysis of fiscal deficits and debt accumulation dynamics in the CEE countries shows that the fiscal tightening is indispensable. An increase in individual, production and property taxes and social contributions together with a rise in unproductive expenditures would have an adverse effect on economic growth. Hence, policy makers should focus on reforms that lower overall expenditures (preferably unproductive ones) rather than increasing taxes.

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Appendices

Appendix 1. Theoretical Background

The requirement that the ratio of debt to GDP converges back towards its initial level is one of the first definitions of sustainable fiscal policy (Buiter, 1985; Blanchard, 1990). However, government debt may remain very high for decades and still experience large fluctuations over time. The former criticism was resolved by defining the sustainability in a more general way. The IMF defines a country's debt sustainable if it is able to continue servicing its debt without an unrealistically large future corrections to the balance of income and expenditures (IMF, 2007). Unsustainable position entails the need for a "drastic" policy changes such as a sudden fiscal tightening which might cause a recession, or even the inability to service the debt, default (Collignon and Mundschenk, 1999). In our paper, we will refer to fiscal sustainability as government capacity, under the current policy mix, to achieve a declared debt ratio while remaining solvent[9].

The starting point of "unpleasant debt arithmetic" is the government budget constraint. The one-period budget constraint is given by:

$$G_t - R_t + r_t B_{t-1} = B_t - B_{t-1} \qquad (1)$$

where G_t is the government expenditures, excluding interest payments; R_t is the government tax revenues; B_t is the real market value of government debt; r_t is the real interest rate; $r_t B_{t-1}$ is interest payments on the level of debt accumulated in the end of the previous period. Alternatively, we can rewrite equation (1) as:

$$\Delta B_t = G_t - R_t = S_t \qquad (2)$$

where S_t is primary budget balance or deficit, the difference between revenues and real expenditures. However, sometimes it may be reasonable to accumulate debt during the bad times and to pay it back during the subsequent boom. Intertemporal budget constraint accounts for short term variations over time.

To derive the lifetime budget constraint first we need to rewrite the flow of budget constraint. Assuming that the government is subject to the same restriction, equation (1) should hold for any value of t in the interval $(1, \infty)$. After several rounds of iterations we would obtain:

$$B_t = \sum_{s=1}^{\infty} \frac{R_{t+s} - G_{t+s}}{\prod_{j=1}^{s}(1+r_{t+j})} + \lim_{s\to\infty} \prod_{j=1}^{s} \frac{B_{t+s}}{(1+r_{t+j})} \qquad (3)$$

Applying a simple arithmetical transformation we obtain:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - G_{t+s}) + \lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} \qquad (4)$$

Equation (4) provides a link between the amount of debt the government has at two dates: t-1 and t + s. In particular, the amount of debt the government has on date t + s is a function of the debt it initially holds at date t, as well as the primary surpluses it ran, and seigniorage it raised between these dates.

[9] For more detailes refer to Afonso (2005), Arestis, et al. (2002) and Arghyrou and Luintel, (2007).

Intuitively, the lifetime budget constraint states that in the case of sustainable fiscal policy present value of existing stock of debt must be equal to the present value of future primary surpluses. This is possible only when the last term in the equation (4), approaches zero: $\lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} = 0$. This equality is frequently referred to as no-Ponzi or transversality condition.

No-Ponzi game condition is a constraint that prevents overaccumulation of debt, i.e. requiring the present value of wealth to be always positive. If the government would allow the debt level to be forever increasing, it would be running a Ponzi-scheme which might ultimately oblige it to repudiate its debt. McCallum (1984) has shown that under certain assumptions a deficit can be maintained permanently without inflation if it is financed by bonds. However, given that a government's taxing capacities are limited, default incentives would grow infinitely.

No-Ponzi scheme condition imposes testable restrictions on the time series of public debt and budget deficit:

i) The value of current public debt must be equal to the sum of future primary surpluses:

$$B_{t-1} = \sum_{s=0}^{\infty} \frac{1}{(1+r)^{s+1}} (R_{t+s} - G_{t+s}) \qquad (5)$$

ii) The present value of public debt must approach zero in infinity:

$$\lim_{s\to\infty} \frac{B_{t+s}}{(1+r)^{s+1}} = 0 \qquad (6)$$

As was mentioned earlier, fiscal sustainability requires the government to be solvent, which means that it is able to hold stable debt/GDP ratio in the long run (weak solvency). Hence, the next step would be to derive government budget constraint in terms of GDP-ratios. For that we simply divide equation (1) by real GDP:

$$\frac{B_t}{Y_t} = \frac{(1+r_t)B_{t-1}}{(1+y_t)Y_{t-1}} + \frac{G_t}{Y_t} - \frac{R_t}{Y_t} \qquad (7)$$

Defining the lower-case letters as ratios of the corresponding upper-case variables to nominal GDP, we simplify the equation (7) to:

$$b_{t-1} = \sum_{s=0}^{\infty} \left(\frac{1+y}{1+r}\right)^{s+1} [\rho_{t+s} - e_{t+s}] + \lim_{s\to\infty} b_{t+s} \left(\frac{1+y}{1+r}\right)^{s+1} \qquad (8)$$

This condition constrains the debt stock to grow faster than the real interest rate (r > y), given that $\lim_{s\to\infty} b_{t+s} \left(\frac{1+y}{1+r}\right)^{s+1} = 0$, unless the primary budget yields a sufficient surplus. To illustrate this, suppose that interest rates on government bonds were smaller than the rate of economic growth. Prolonged periods of deficits do not indicate an unsustainable fiscal position. In such economy the budget constraint is in fact irrelevant as debt can be rolled over indefinitely. However, if the interest rate were to surpass the GDP growth rate with some positive probability, even zero primary surpluses would become unsustainable (Claeys, 2007).

Appendix 2. Literatute reiew

Table 2.1. Empirical evidence regarding fiscal sustainability

Study	Period	Country study	Methodology	Model specification	Is the fiscal policy sustainable?
Bohn (1998)	1916-1995, annual frequency	USA	OLS with NeweyWest S.E., GVAR and YVAR fiscal variables, extensions: fiscal fatigue (second and third polynomial terms, break at 34%); subsamples,	Primary surpluses and public debt	The primary surplus has historically responded positively to increases in debt.
Galí and Perotti (2003)	1980–2002, annual frequency	EU-11+OECD-5	FE and IV FE estimator with country fixed effects, extensions: debt as a fraction of potential GDP, expected output gap, pre- vs. post-Maastricht period; monetary policy rule; government investment, spending, and revenues to potential output;	CAPB and general government primary deficit divided by potential output	The bihaviour of discretionary fiscal policy during recessions turned from being somewhat pro-cyclical to becoming counter-cyclical.
Abiad and Ostry (2005)	1990–2002, annual frequency	31 EM's	FGLS estimator, debt spline at 50%; extensions: alternative fiscal institution measures;	Debt ratio	Primary surpluses respond positively to increases in debt at low and moderate levels of debt but it gets only marginally responsive at high levels; The primary balance behaves in a procyclical manne
Golinelli and Momigliano (2006)	1988–2006, annual frequency	19 OECD and EU-11	Real-time data, various estimators (OLS, FE, GMM), country and fixed effects; extensions: dummy variables for stages of European monetary integration, phases of RBC and election cycle, a Maastricht variable (number of years for elimination of the excessive deficit and expected interest payments); testing symmetry of fiscal responses;	Change of CAPB, lagged PB included	Fiscal policies react in a stabilizing manner to the initial state of public finances; There is countercyclical reaction of fiscal policy to economic conditions.
Debrun et al. (2008)	1990–2005, annual frequency	EU-25	OLS, LSDVC, FE and FE IV estimator with country fixed effects; extensions: subgroups estimations, focus on fiscal rules;	General government and cyclically adjusted balance	Balanced budget and debt rules have a stronger and significant effect in determining higher cyclcically adjusted primary balances
Mendoza and Ostry (2008)	1980/1990–2005, annual frequency	22 DM's and 34 EM's	FE estimator with country-fixed effects, robust S.E. with country AR(1) coefficients; extensions: subsamples (high/low debt countries); spline regression (threshold at 48%); shorter periods for most emerging countries; YVAR and GVAR government expenditure variables;	Lagged debt, output gap	The primary balance responds in corrective manner to increases in debt; The primary balance behaves in a countercyclical manner;
Afonso and Jalles (2011)	1970–2010, annual frequency	18 OECD	Pooled OLS and FE IV estimators, system GMM estimator, narrow specification (debt and/or output gap only) extensions: panel time series estimation (MG, AMG, CCEMG) and Driscoll-Kraay estimator.	First-differenced level of government debt/GDP	The primary balance responds in a corrective manner to an increasing public debt; The primary balance responds in a countercyclical manner to business cycle fluctuations.

Appendix 2. Literatute reiew

Table 2.1. Empirical evidence regarding fiscal sustainability (continued)

Study	Period	Country study	Methodology	Model specification	Is the fiscal policy sustainable?
Eller and Urvová (2012)	1995–2011, annual frequency	8 new EU member states	Pooled OLS, FE, system GMM estimators with fixed and time effects; extensions: debt spline (at 40%), output gap analysis, various election variables and price indices, fiscal institutions (FRI, WB governance).	Lagged PB, lagged debt ratio, CPI, Crisis dummy, output gap	The primary balance responds in a corrective manner to an increasing public debt; The primary balance responds in a countercyclical manner to business cycle fluctuations.
Ghosh et al. (2013)	1970/1985–2007, annual frequency	23 DE's	FE estimator with robust S.E. and with AR(1) error term process; extensions: fiscal fatigue explored (coefficients of the second and third polynomial), government expenditure gap;	Lagged debt, output gap, government expenditure debt	The marginal response of primary balance to lagged debt is nonlinear, remaining positive at moderate debt levels but starting to decline when debt reaches around 90-100 percent of GDP.
Debrun and Kinda (2013)	1980–2010, annual frequency	28 DM's and 26 EM's	FE and LSDVC estimator; extensions: interest payments, and interest payments thresholds (linear);	Lagged PB, lagged debt, output gap, crisis dummy	The primary balance responds in corrective manner to increases in debt; The primary balance behaves in a countercyclical manner;
Debrun and Kinda (2014)	1990–2011, annual frequency	28 DM's and 26 EM's	LSDVC estimator; extensions: exploring fiscal rules and fiscal councils;	Lagged PB, lagged debt, lagged output gap, fiscal rule index, time dummies	The primary balance responds in corrective manner to increases in debt; The primary balance behaves in a countercyclical manner;
D'Erasmo, Mendoza, Zhang (2015)	1951–2013, annual frequency	25 DM's and 33 EM's	FE with White cross-section corrected S.E. with output gap and government expenditures; extensions: government expenditure or consumption gap (HP filter), country AR(1) error.	Lagged debt, gdp gap	There is positive, conditional response of the primary balance to debt and to gdp gap meaning countercyclical behaviour.
Baldi and Staehr (2016)	2001Q1–2008Q2; 2009Q1–2014Q1	EU-27	2SLS estimation with robust S.E., country fixed effects and quarterly dummies with GDP growth only; variables are not seasonally adjusted. Extensions: various subgroups of countries (EA12, CEE10, old and new EU countries grouped by "seriousness" of their fiscal problems);	Lagged PB, lagged debt, output gap	Little feedback from the debt stock to the primary balance in the pre-crisis period; Much more feedback in the crisis period; The primary balance behaves in a persistent and countercyclical manner.

Source: Afonso (2004) and Checherita-Westphal and Žďarek (2017) and a survey from the authors.

Appendix 3. Data sources

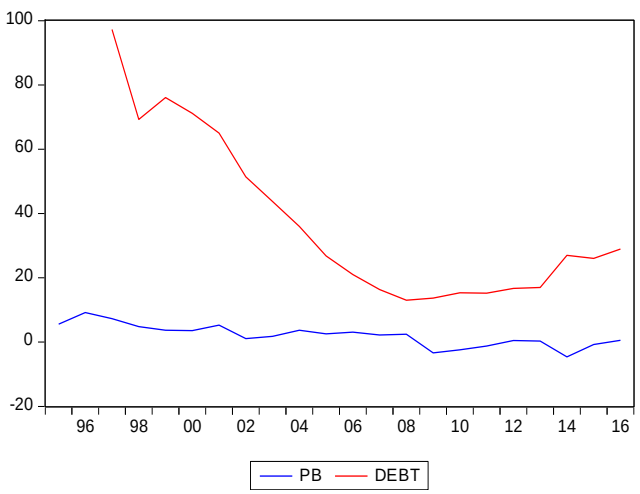
Table 3.1. Variables description and sources

Fiscal policy reaction function main variables		
Variable	**Definition**	**Source**
Debt ratio (d_{it})	General government consolidated gross debt, Excessive deficit procedure (based on ESA 1995) and former definition (linked series) (% of GDP at market prices)	AMECO(UDGG)
Primary balance (pb_{it})	General government primary balance (ESA 1995, EDP) (% of GDP at market prices)	AMECO(UBLGI)
Current account (ca_{it})	Current account, Balance of payments statistics (% of GDP at market prices)	AMECO (UBCABOP)
Financial crisis dummy (D_{it}^{fc})	Dummy equal to one for country-year observations in which there is a banking, currency and/or sovereign debt crisis, and zero otherwise.	Laeven and Valencia (2012)
Price index ($hcpi_{it}$)	Harmonised consumer price index: all items (HICP)	AMECO (PVGD, ZCPIH)
Output gap (gap_{it})	Gap between actual and potential gross domestic product at 2010 reference levels (% of GDP at market prices)	AMECO (AVGDGP)
Shadow rate (ump)	The policy rate as it would be if it could be negative, based on asset purchases and other unconventional tools.	Wu and Xia (2017,2014)
Election dummy (D_{it}^{elect})	Dummy that is 1 when an election (legislative or presidential) was held in a certain year, 0 otherwise;	Internet sources
Old-age dependency ratio (odr_{it})	The ratio between the number of persons aged 65 and over (age when they are generally economically inactive) and the number of persons aged between 15 and 64.	Eurostat
Fiscal rules index (fri_{it})	Fiscal rules index; Sum of fiscal rule strength indices in force in the respective Member State weighted by the coverage of general government finances of the respective rule (i.e. public expenditure of the government sub sector(s) concerned by the rule over total general government expenditure).	EC database
Interest payments (int_{it})	The absolute volume of payments (ESA 1995); (as % of GDP, lagged debt or total revenues)	AMECO (UYIG)
Instrumental variables		
Variable	**Definition**	**Source**
Trade openness	Sum of exports and imports (% of GDP at market prices)	IMF WEO
US GDP growth	Growth rate of GDP at market prices	OECD
Russia GDP growth	Growth rate of GDP at market prices	OECD
Oil prices growth	Growth rate of the oil price: Crude Oil (petroleum), Price index, 2005 = 100, simple average of three spot prices; Dated Brent, West Texas Intermediate, and the Dubai Fateh	IMF WEO
Non-fuel commodity price	Non-Fuel Price Index, 2005 = 100, includes Food and Beverages and Industrial Inputs Price Indices	IMF WEO
US short-term interest rate	Short-term interest rate in the USA	OECD
Potential GDP	Potential GDP at 2010 reference levels	AMECO
Unemployment rate	Unemployed % of active population (EUROSTAT definition)	AMECO

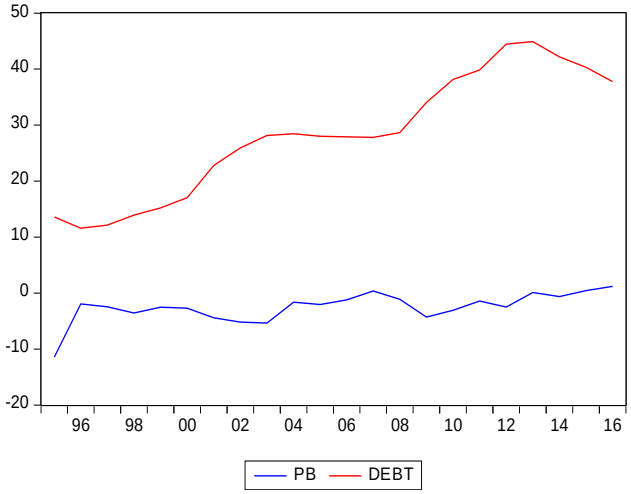
Note: * series from the European Commission AMECO database (updated on 13/02/2017).

Appendix 4. Evolution of main fiscal series in CEE countries

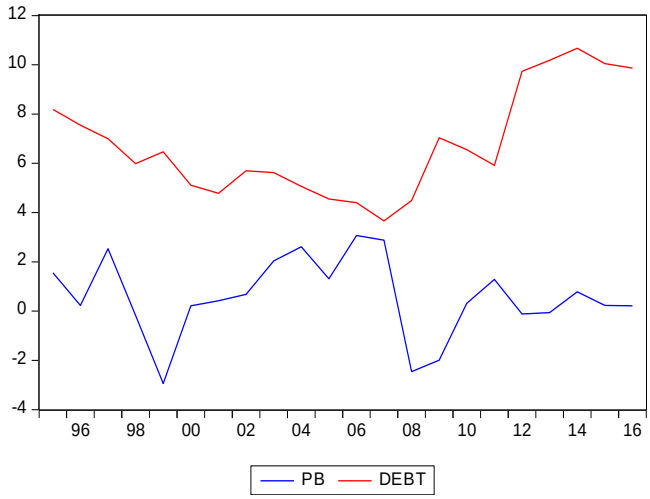
Fig. 4.1. Fiscal series: government debt and primary balance, 1995-2016



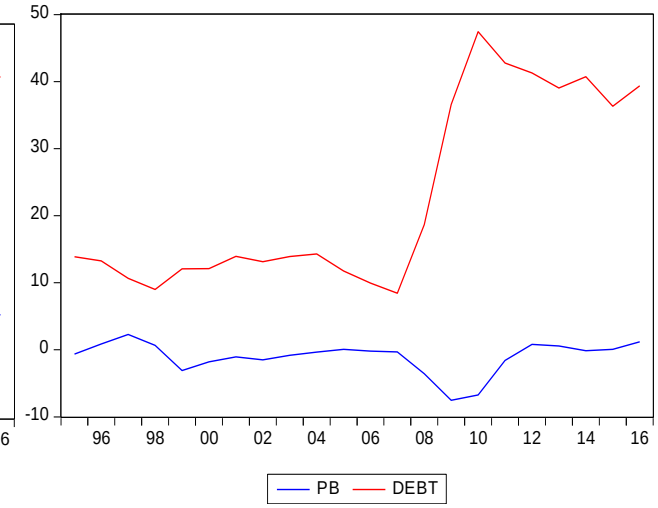
Bulgaria



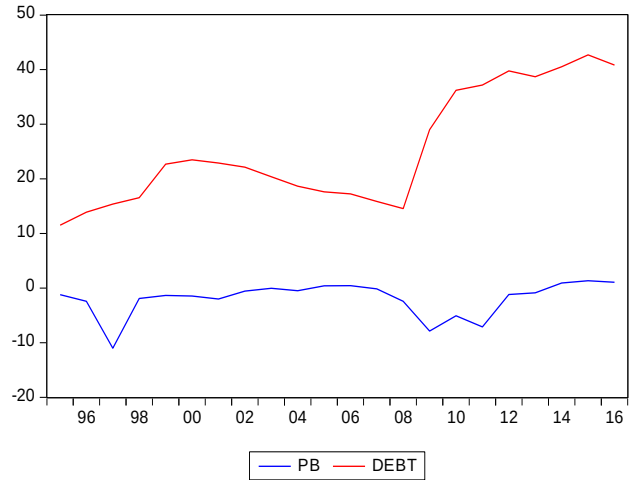
Czech Republic

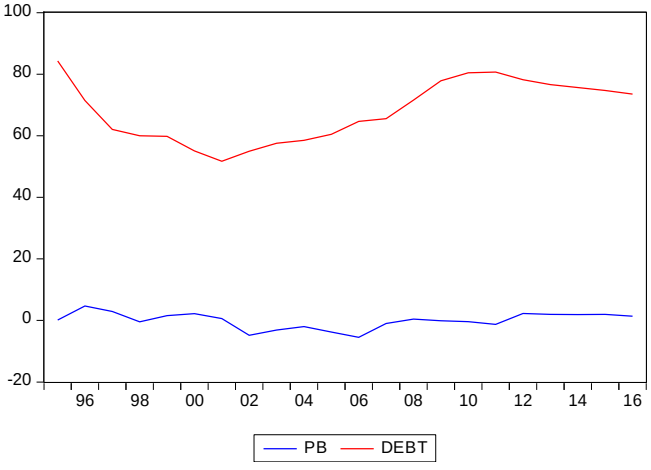


Estonia

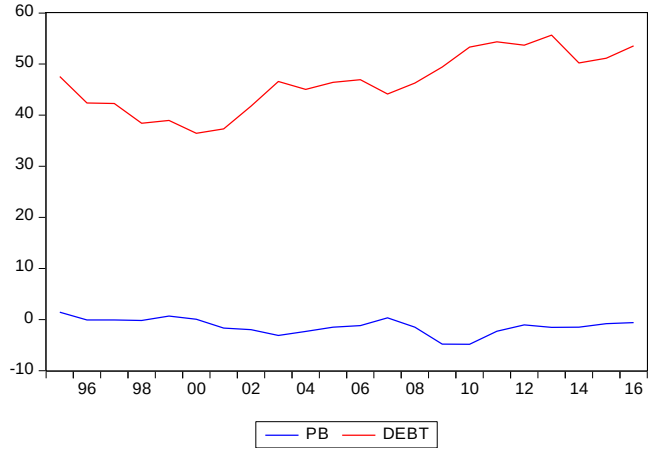


Latvia

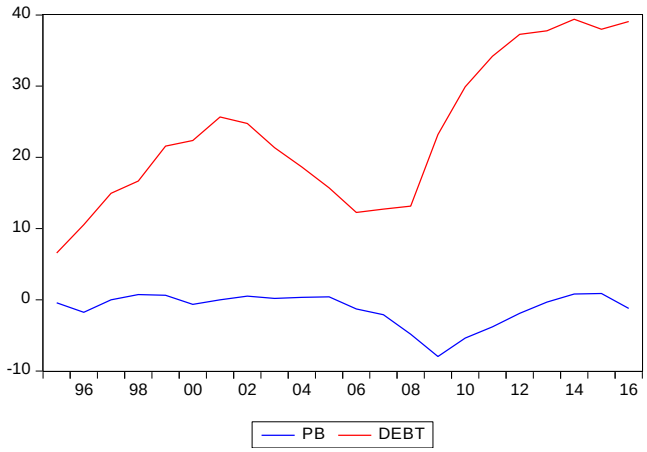




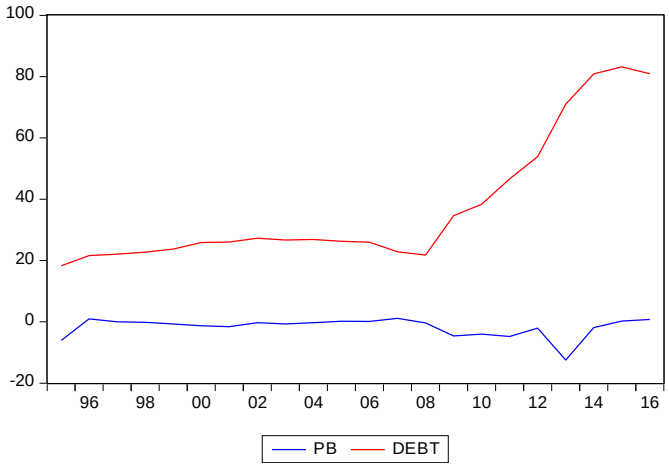
Lithuania



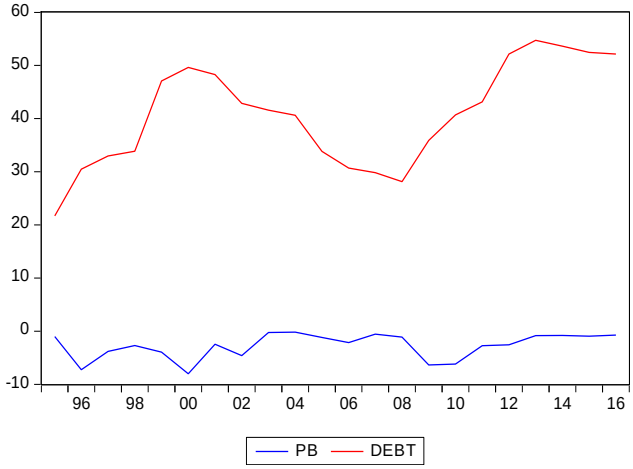
Hungary



Poland



Romania



Slovenia

Slovakia

Source: Authors, using data from European Commission AMECO (Annual Macro-Economic Data).

Table 4.1. Summary statistics of main FPRF variables

Country	Government debt				Primary balance			
	Mean	Max	Min	Jarque-Bera test	Mean	Max	Min	Jarque-Bera test
Bulgaria	37.3483	97.2611	13.031	2.9855	2.0604	9.2162	-4.5864	0.0613
Czech Republic	28.3115	44.9086	11.5915	1.3534	-2.5153	1.1969	-11.4284	**21.8426*** **
Estonia	6.7532	10.671	3.6636	1.95	0.5742	3.0728	-2.943	0.8665
Latvia	22.6624	47.4331	8.4301	3.2206	-1.035	2.2845	-7.5352	**10.4699*** **
Lithuania	25.3568	42.6983	11.5203	2.5109	-1.9527	1.3213	-11.0213	**11.4082*** **
Hungary	67.9695	84.2932	51.7037	1.7263	-0.0139	4.6875	-5.455	1.0905
Poland	46.4618	55.682	36.4532	1.0566	-1.2945	1.4375	-4.8527	1.9535
Romania	23.445	39.3858	6.5694	1.5666	-1.236	0.8764	-7.9593	**9.8505*** **
Slovenia	37.6192	83.149	18.3089	**5.6169***	-1.7083	1.1551	-12.4624	**34.3708*** **
Slovakia	40.7484	54.7392	21.672	1.2437	-2.7486	-0.1751	-8.0243	3.0944
Country	**Current Account**				**Output gap**			
	Mean	Max	Min	Jarque-Bera test	Mean	Max	Min	Jarque-Bera test
Bulgaria	-5.7474	4.2	-23.9	4.3337	0.2927	5.2039	-4.3767	0.579
Czech Republic	-2.8182	1.1	-6.2	0.6866	0.0934	5.8003	-3.0887	3.1431
Estonia	-5.5954	2.7	-15.0	1.6374	0.8313	14.3678	-9.0085	0.4706
Latvia	-5.8941	7.8	-20.7	0.7189	0.0086	10.5865	-12.1649	1.7439
Lithuania	-4.2615	3.6	-15.1	1.0783	-0.1732	8.8653	-10.4815	0.4082
Hungary	-3.4136	4.8	-8.5	2.4218	-0.2821	4.4199	-4.4428	0.4668
Poland	-3.6692	-0.3	-6.7	0.907	-0.0438	2.8163	-4.3161	1.5758
Romania	-5.5889	-0.7	-13.8	1.6114	-0.1871	7.4818	-5.3262	1.9792
Slovenia	0.1091	6.8	-5.3	1.5264	-0.2462	6.826	-5.6682	1.2671
Slovakia	-4.0231	1.9	-10.6	0.9993	-0.1041	7.1957	-3.5866	**4.9755***

Source: Data obtained from European Commission AMECO (Annual Macro-Economic Data).

Appendix 5. Stylized facts on public finance in CEE countries

Policy-makers in most EU countries faced substantial problems of keeping fiscal discipline and balanced budgets. In many member states gross national debt levels reached 100% of GDP by 2016 and in some cases have even exceeded this limit. As can be seen from figure 2 government debt during the last two decades have increased substantially from 70.8% of GDP in 1995 to 91.5% of GDP in 2016, raising serious concerns regarding the sustainability of monetary union (Fig.1.).

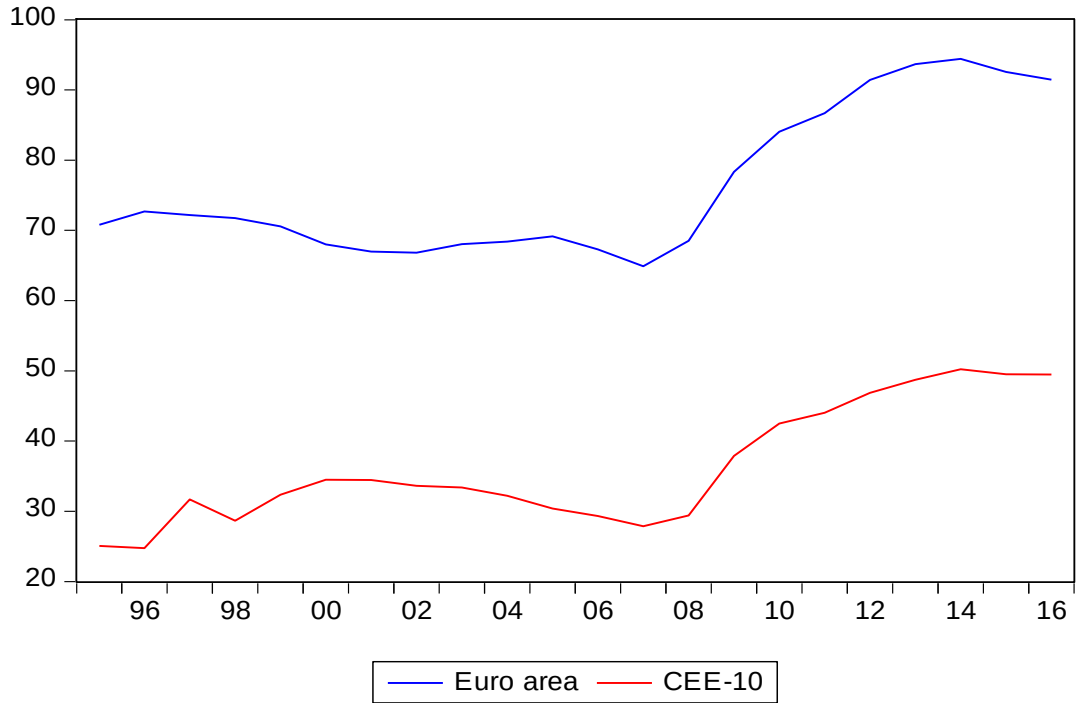


Figure 1: Public Debt of Euro area and CEE countries, in percent of GDP

Source: Authors, using data from European Commission AMECO (Annual Macro-Economic Data).

Comparing with advanced European economies the average public debt-to-GDP ratio for CEE countries has been safely below 60% of GDP, with the highest ratio recorded in Slovenia, Hungary, Poland and Slovakia. Most of the CEE countries entered the EU with small explicit liabilities (Fig.2.). For instance, Romania repaid all the external debt in 1989, Poland made special arrangements with their creditors. Hence, they did not have time for debt accumulation. Overall, low values of public debt suggest "good" and sustainable fiscal policy, but a deeper investigation of public finances highlights some issues that might make fiscal policy vulnerable from the perspective of the IBC.

In addition, CEE countries faced many challenges connected to their young market economy status. First of all, CEE countries have not enjoyed the benefits of prolonged economic growth compared to other advanced economies. This fact has prevented the governments from raising sufficient buffer funds to sustain the economy over the cyclical downturns (with exception of Estonia).

Growing needs in capital investments during transition period made CEE-10 governments compete in the “great fiscal loosening race”, in order to stimulate investments and economic growth. In Czech

Republic, Hungary and Poland, the loosening took place from 1999 to 2003, and represented a fiscal relaxation of 0.75% of GDP per year. In the other CEE countries, it was lasting for seven years, but had a smaller annual relaxation of around 0.38%.

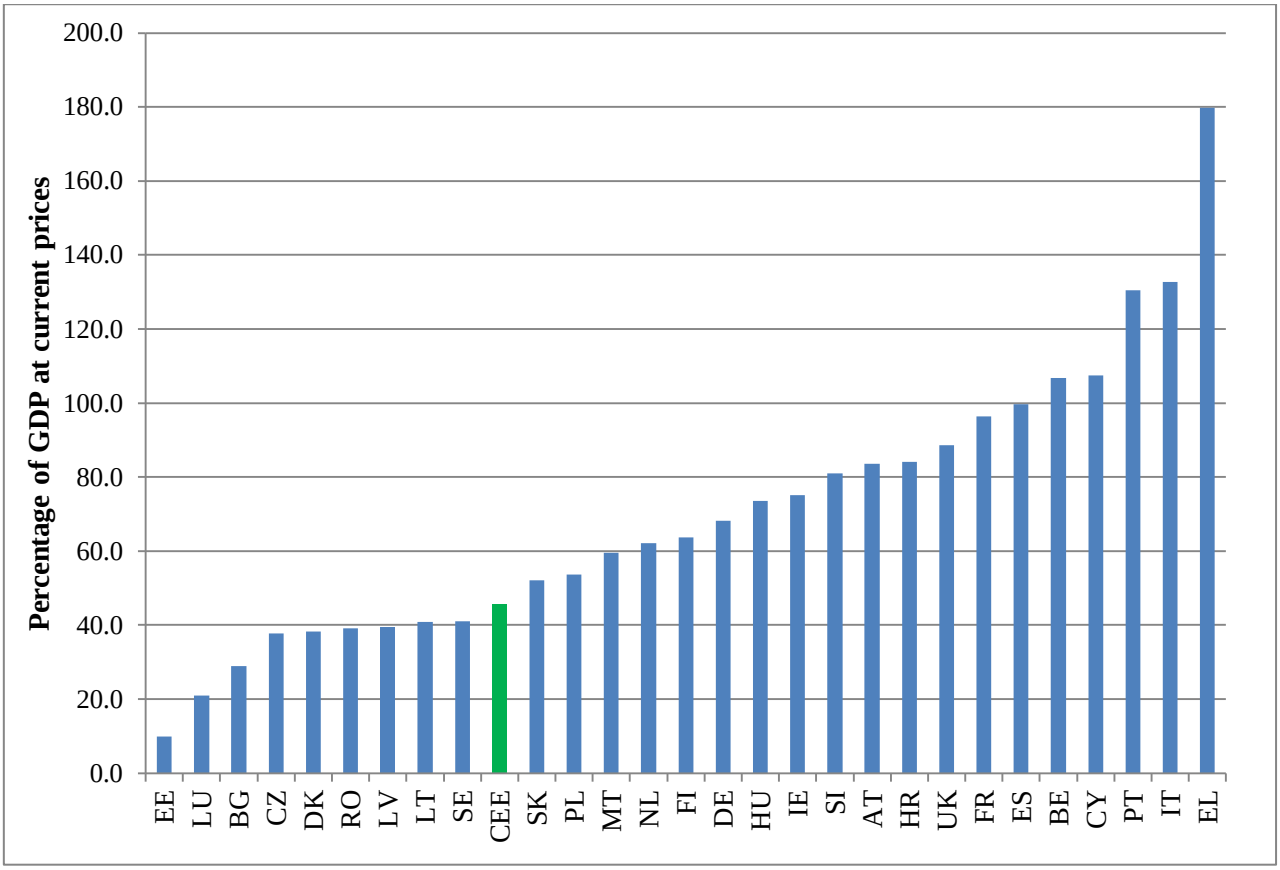


Figure 2. Government Debt-GDP Ratio in the 28 EU (2016)

Source: Authors, using data from European Commission AMECO (Annual Macro-Economic Data).

For many Central and Eastern European economies, the membership in monetary union opened access to cheap borrowing to finance current deficits. The real implicit interest rate on public debt was much lower in CEE countries than in EU-15 countries. This led to increased public debt accumulation and consumption spending. Strong reliance on foreign capital together with expansionary spending policies during 2000-2007 made public finances vulnerable to the economic downturn. As was argued by Calvo et al. (2003) sudden stop in capital flows can force abrupt adjustments in current account deficits that in turn may compromise the ability to service public debt in the future. As a result, almost all CEE countries entered the crisis with weak budgetary positions. The average fiscal deficit rose substantially to 6% of GDP in 2009, up from a pre-crisis level of around 2%. The increase in the deficit was accompanied by high budget debt and resulted notably in the pushing up of interest payments during the recession (Zaidi and Rejniak's, 2010).

As the euro area sovereign debt crisis escalated, the government implemented various stimulus packages. For instance, Poland fuelled about €20.6 billion into the economy during 2008. It enacted a discretionary fiscal relaxation of 4.5% of GDP and allowed the automatic stabilisers to work. As a result, the fiscal balance, after having significantly improved during 2006 and 2007, went up from less

than 2% of GDP in 2007 to above 7% of GDP in 2009, becoming is one of the highest rates among CEE countries (Zaidi and Rejniak's, 2010).

While other states did their best to boost economic growth by fueling their economy out of recession, Baltic countries had already experienced serious expenditures cuts in the previous years of the 2008 recession, thus efficiently reducing the impact of the crisis. Of all CEE states, Estonia has been doing the best in terms of holding sustainable deficit and debt levels. It was enjoying a substantial government surplus of 2.5% of GDP in 2006 and in 2009 had a small deficit of only 1.7% of GDP.

After the aggressive phase of the recession ended governments enacted various consolidation plans, cutting back on spending through 2011. On the revenue side, countries managed to shift the tax burden to more neutral forms of taxation—such as the Value-Added Tax. On the spending side, countries implemented large cuts in public investment. However, Lithuania and Slovenia managed even to increase capital spending, despite fiscal consolidation. The effect of these policy measures was a rapid deficit reduction, which in turn suppressed revenue streams and keeps them trapped below pre-crisis levels.

Appendix 6. Individual unit root test results

Table 6.1. Unit root tests for the government debt to GDP, (1995–2015)

Country	Assumption	Augmented Dickey-Fuller (ADF) test[a)]	Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test[b)]	Ng-Perron (NP) test[c)]			
				MZa	MZt	MSB	MPT
		t-stat	LM-stat	NP-stat	NP-stat	NP-stat	NP-stat
		(1)	(2)	(3)	(4)	(5)	(6)
Bulgaria	Intercept	**-3.1125***	**0.4821****	-0.2241	0.23	1.0262	55.1086
	Trend and Intercept	-3.0322	**0.1678****	-0.0178	-0.0099	0.5568	70.1365
Czech Republic	Intercept	-2.0546	**0.6061****	-0.2052	-0.1616	0.7877	35.3839
	Trend and Intercept	1.0447	0.0682	-8.5419	-1.8235	0.2135	11.3705
Estonia	Intercept	-0.9302	0.2882	-2.2812	-0.9308	0.408	9.7646
	Trend and Intercept	-1.8236	**0.1678****	-1.6435	-0.8262	0.5027	48.4047
Hungary	Intercept	-2.2487	0.3069	-3.3467	-1.2914	0.3859	7.3185
	Trend and Intercept	-1.2031	**0.1267***	-1.9681	-0.9916	0.5038	46.2736
Latvia	Intercept	-1.2707	**0.504****	-1.5525	-0.7112	0.4581	12.612
	Trend and Intercept	1.3856	0.1175	-5.5599	-1.6663	0.2997	16.3868
Lithuania	Intercept	-0.6929	**0.5196****	-0.3498	-0.1823	0.5211	18.7191
	Trend and Intercept	**-3.6408***	0.1134	-5.2746	-1.6216	0.3074	17.2658
Poland	Intercept	-0.2431	**0.5052****	2.2288	-0.9328	0.4185	10.048
	Trend and Intercept	0.0431	0.0985	-3.9672	-1.408	0.3549	22.964
Romania	Intercept	0.5527	**0.4623***	-0.9999	-0.433	0.433	13.3633
	Trend and Intercept	-0.6798	0.0997	-6.1556	-1.7483	0.284	14.7968
Slovakia	Intercept	**-3.4547*****	0.2793	-2.4499	-0.9141	0.3731	8.9458
	Trend and Intercept	**-3.4544***	0.0909	-5.2899	-1.6235	0.3069	17.2143
Slovenia	Intercept	0.7697	**0.5143****	1.5856	1.1082	0.6989	40.9678
	Trend and Intercept	-1.6764	**0.1563****	-1.5212	-0.7305	0.4802	46.1569

Note: Tests were carried out by using Eviews 8.

*** denotes statistical significance at the 1 per cent level of significance, ** denotes statistical significance of the structural break at the 5 per cent level of significance while * denotes statistical significance of the structural break at the 10 per cent level of significance.

a) For ADF test automatic lag length selection based on Akaike Information Criterion (AIC) with a maximum lag of 8. The maximum lag length is calculated by Schwert (1989) rule of thumb: $p_{max} = \left[12 \cdot \left(\frac{T}{100}\right)^{1/4}\right]$.

b) The KPSS test based on Newey-West automatic bandwidth selection and Bartlett kernel. Asymptotic critical values reported by Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1) are 0.739, 0.463 and 0.347 for 1, 5 and 10% levels respectively , for the model with intercept, in case of model with a trend and intercept critical values are 0.216, 0.146 and 0.119.

c) The NP test based on Newey-West automatic bandwidth selection and Bartlett kernel Test critical values reported by Ng and Perron (Table 1, 2001) for the level stationarity are given:

	MZa	MZt	MSB	MPT
1%	-13.8000	-2.58000	0.17400	1.78000
5%	-8.10000	-1.98000	0.23300	3.17000
10%	-5.70000	-1.62000	0.27500	4.45000

Table 6.2. Unt root tests for the primary balance to GDP, (1995–2015)

Country	Assumption	Augmented Dickey-Fuller (ADF) test[a)]	Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test[b)]	Ng-Perron (NP) test[c)]			
				MZa	MZt	MSB	MPT
		t-stat	LM-stat	NP-stat	NP-stat	NP-stat	NP-stat
		(1)	(2)	(3)	(4)	(5)	(6)
Bulgaria	Intercept	-1.8982	**0.5867****	-3.0579	-1.1978	0.3917	7.93
	Trend and Intercept	-1.7909	0.108	-6.7418	-1.71	0.2536	13.5594
Czech Republic	Intercept	**-4.9418*****	**0.5978****	-3.2616	-1.0389	0.3185	7.2311
	Trend and Intercept	**-3.5564***	0.0595	-6.5584	-1.8077	0.2756	3.8941
Estonia	Intercept	2.307	0.0849	**-6.2682***	**-1.7622***	**0.2811***	**3.9339***
	Trend and Intercept	1.4147	0.0665	-6.3967	-1.7884	0.2796	14.2456
Hungary	Intercept	-2.219	0.1776	**-7.332***	**-1.8991***	**0.259***	**3.3958***
	Trend and Intercept	-2.4495	**0.1772****	-7.0541	-1.8632	0.2641	12.9325
Latvia	Intercept	-1.0417	0.1155	**-8.5084****	**-2.0213****	**0.2376****	**3.0299****
	Trend and Intercept	-2.7783	0.0949	8.6271	-2.0164	0.2337	10.751
Lithuania	Intercept	**-2.9345****	0.1142	**-8.7017****	**-2.0442****	**0.2349****	**2.9684****
	Trend and Intercept	-1.7306	0.0798	-9.8254	-2.1963	0.2235	9.3573
Poland	Intercept	**-6.5406*****	0.3141	-5.254	-1.6207	0.3085	4.6634
	Trend and Intercept	**-7.0579*****	**0.1319***	-7.2614	-1.8116	0.2495	12.6733
Romania	Intercept	-2.2476	0.1697	-5.414	-1.6449	0.3038	4.5263
	Trend and Intercept	-1.8	0.0896	-5.8725	-1.7006	0.2896	15.4919
Slovakia	Intercept	-1.257	0.2554	**-9.7946****	**-2.1918****	**0.2238****	**2.581****
	Trend and Intercept	**-4.2047****	0.0672	-9.0554	-2.1202	0.2341	10.0901
Slovenia	Intercept	-2.0934	0.1909	**-10.0861****	**-2.187****	**0.2168****	**2.6485****
	Trend and Intercept	-2.1929	0.092	-8.0896	-1.9581	0.242	11.3986

Note: Tests were carried out by using Eviews 8.

*** denotes statistical significance at the 1 per cent level of significance, ** denotes statistical significance of the structural break at the 5 per cent level of significance while * denotes statistical significance of the structural break at the 10 per cent level of significance.

a) For ADF test automatic lag length selection based on Akaike Information Criterion (AIC) with a maximum lag of 8. The maximum lag length is calculated by Schwert (1989) rule of thumb: $p_{max} = \left[12 \cdot \left(\frac{T}{100}\right)^{1/4}\right]$.

b) The KPSS test based on Newey-West automatic bandwidth selection and Bartlett kernel. Asymptotic critical values reported by Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1) are 0.739, 0.463 and 0.347 for 1, 5 and 10% levels respectively , for the model with intercept, in case of model with a trend and intercept critical values are 0.216, 0.146 and 0.119.

c) The NP test based on Newey-West automatic bandwidth selection and Bartlett kernel Test critical values reported by Ng and Perron (Table 1, 2001) for the level stationarity are given:

	MZa	MZt	MSB	MPT
1%	-13.8000	-2.58000	0.17400	1.78000
5%	-8.10000	-1.98000	0.23300	3.17000
10%	-5.70000	-1.62000	0.27500	4.45000

Table 6.3. Tests for Structural Change in the Public Debt series, (1995–2015)

Country	Assumption	Zivot and Andrews (1992)[a]		Lumsdaine and Papell (1997)[b]		
		t-stat	$\hat{T}_1$	t-stat	$\hat{T}_1$	$\hat{T}_2$
		(1)	(2)	(3)	(4)	(5)
Bulgaria	Intercept	Na	Na	**-7.8055*** **	**2005**	**2013**
	Trend and Intercept	Na	Na	-5.8986	2007	2010
Czech Republic	Intercept	**-0.2576***	**2007**	-1.9045	2006	2010
	Trend and Intercept	**-5.9769****	**2005**	-5.3375	2004	2011
Estonia	Intercept	**-4.3854*****	**2012**	**-9.2491*****	**2008**	**2011**
	Trend and Intercept	-3.5264	2006	-5.9851	2008	2011
Hungary	Intercept	**-3.4236*****	**2008**	**-8.1810*****	**2007**	**2013**
	Trend and Intercept	**-3.649*****	**2008**	-6.6753	2002	2012
Latvia	Intercept	**-1.0551***	**2012**	-1.7294	2007	2013
	Trend and Intercept	**-5.8861*****	**2009**	**-9.1194*****	**2008**	**2011**
Lithuvania	Intercept	-4.0326	2007	-3.5942	2007	2010
	Trend and Intercept	**-3.8269*****	**2009**	**-6.8223****	**2000**	**2008**
Poland	Intercept	-5.3833	2009	**-7.3695*****	**2009**	**2013**
	Trend and Intercept	**-6.2836****	**2010**	-6.1462	2009	2012
Romania	Intercept	**-4.7444****	**2003**	**-6.4586****	**2002**	**2008**
	Trend and Intercept	**-4.4737***	**2003**	-4.9563	2002	2008
Slovakia	Intercept	-3.8808	2008	-4.6974	2007	2011
	Trend and Intercept	-4.7596	2007	**-7.6579*****	**2006**	**2009**
Slovenia	Intercept	-3.3568	2013	-4.3106	2007	2012
	Trend and Intercept	-5.128	2007	**-9.0167*****	**2008**	**2013**

Note: Tests were carried out by using Rats 9.10.

*** denotes statistical significance at the 1 per cent level of significance, ** denotes statistical significance of the structural break at the 5 per cent level of significance while * denotes statistical significance of the structural break at the 10 per cent level of significance.

a) For Zivot and Andrews test automatic lag length selection based on Akaike Information Criterion (AIC) with a maximum lag of 7. Asymptotic distribution of the minimum t-statistic and critical values are provided by Zivot and Andrews (1992, Table 1) : -5.34 (for 1 per cent level) and -4.93 (5 per cent level) and -4.58.

b) The Lumsdaine and Papell test based on based on Akaike Information Criterion (AIC) with a maximum lag of 8. Asymptotic critical values reported by Lumsdaine and Papell (1997, Table 1) are -6.74, -6.16 and -5.89 for 1, 5 and 10% levels respectively .

Table 6.4. Tests for Structural Change in the Primary Balance, (1995–2015)

Country	Assumption	Zivot and Andrews (1992)[a]		Lumsdaine and Papell (1997)[b]		
		t-stat	$\widehat{T}_1$	t-stat	$\widehat{T}_1$	$\widehat{T}_2$
		(1)	(2)	(3)	(4)	(5)
Bulgaria	Intercept	-3.1262	2005	-3.1420	2006	2011
	Trend and Intercept	-3.8087	2006	**-11.0281*** **	**2005**	**2013**
Czech Republic	Intercept	**-8.029****	**2014**	**8.2447*** **	**2010**	**2013**
	Trend and Intercept	**-4.5348*** **	**2009**	**-11.3042*** **	2005	2013
Estonia	Intercept	**-5.1186*** **	**2008**	-5.7307	2002	2007
	Trend and Intercept	-4.8996	2008	**-12.6343*** **	**2000**	**2007**
Hungary	Intercept	**-4.4815*** **	**2002**	**-6.1092***	**2001**	**2011**
	Trend and Intercept	**-6.04*** **	**2002**	**-8.6146*** **	**2001**	**2007**
Latvia	Intercept	**-6.8169***	**2013**	**-7.5785*** **	**2006**	**2011**
	Trend and Intercept	**-6.9193*** **	**2008**	**-9.3723*** **	**2006**	**2013**
Lithuvania	Intercept	**-4.2277****	**2008**	-5.7607	2008	2012
	Trend and Intercept	**-5.5315****	**2009**	-6.2024	2008	2012
Poland	Intercept	**-4.0547***	**2013**	-5.3966	2006	2013
	Trend and Intercept	**-5.0063***	**2009**	**-7.0369****	**2002**	**2008**
Romania	Intercept	**-4.199***	**2008**	**-6.5186****	**2007**	**2012**
	Trend and Intercept	**-4.9227****	**2008**	-5.9510	2006	2010
Slovakia	Intercept	-4.6709	2006	**-7.1820*** **	**1999**	**2008**
	Trend and Intercept	**-6.4654*** **	**2009**	-7.0920**	2002	2008
Slovenia	Intercept	**-5.2203****	**2013**	**-9.0682*** **	**2006**	**2012**
	Trend and Intercept	**-4.0066*** **	**2013**	-3.6342	2006	2010

Note: Tests were carried out by using Rats 9.10.

*** denotes statistical significance at the 1 per cent level of significance, ** denotes statistical significance of the structural break at the 5 per cent level of significance while * denotes statistical significance of the structural break at the 10 per cent level of significance.

a) For Zivot and Andrews test automatic lag length selection based on Akaike Information Criterion (AIC) with a maximum lag of 8.Critical values reported by Zivot and Andrews (1992, Table 1) are -5.34 (for 1 per cent level) and -4.8 (5 per cent level).

b) The Lumsdaine and Papell test based on based on Akaike Information Criterion (AIC) with a maximum lag of 8. Asymptotic critical values reported by Lumsdaine and Papell (1997, Table 1) are -6.74, -6.16 and -5.89 for 1, 5 and 10% levels respectively .

Appendix 7. Results of first generation panel unit root tests

Table 7.1. Panel data unit root tests for the government debt-to-GDP ratio, (1995–2015)

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	1.14745	0.8744	10	181
Breitung t-stat	0.81962	0.7938	10	171
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-0.52562	0.2996	10	181
ADF - Fisher Chi-square	27.7927	0.1144	10	181
PP - Fisher Chi-square	16.4229	0.6901	10	198

Note: Tests were carried out by using Eviews 8.
Automatic lag length selection based on SIC; Newey-West automatic bandwidth selection and Bartlett kernel
Levin, Lin and Chu (2002) allows for fixed effects and unitspecific time trends, whereas the coefficient on the lagged dependent variable is restricted to be homogeneous across all units of the panel. In contrast, the Im, Pesaran and Chin (1997) test allows for individual unit root processes, letting the coefficient on the lagged dependent variable to vary across cross sections. While the alternative hypothesis to the null of unit root in the LLC test is that all series are stationary, the alternative in the IPS framework is that some cross sections are without unit root. The null hypothesis being tested by Fisher-type tests is that all panels contain a unit root. The alternative is that at least one panel is stationary.

Table 7.2. Panel data unit root tests for the primary balance-to-GDP ratio, (1995–2015)

Method	Statistic	Prob.**	Cross-sections	Obs
Null: Unit root (assumes common unit root process)				
Levin, Lin & Chu t*	-2.37942	0.0087	10	190
Breitung t-stat	-2.89683	0.0019	10	180
Null: Unit root (assumes individual unit root process)				
Im, Pesaran and Shin W-stat	-4.03054	0.0000	10	190
ADF - Fisher Chi-square	49.1839	0.0003	10	190
PP - Fisher Chi-square	48.8653	0.0003	10	200

Note: Tests were carried out by using Eviews 8.
Automatic lag length selection based on SIC; Newey-West automatic bandwidth selection and Bartlett kernel
Levin, Lin and Chu (2002) allows for fixed effects and unitspecific time trends, whereas the coefficient on the lagged dependent variable is restricted to be homogeneous across all units of the panel. In contrast, the Im, Pesaran and Chin (IPS henceforth, see Im et al., 1997) test allows for individual unit root processes, letting the coefficient on the lagged dependent variable to vary across cross sections. While the alternative hypothesis to the null of unit root in the LLC test is that all series are stationary, the alternative in the IPS framework is that some crosssections are without unit root. The null hypothesis being tested by Fisher-type tests is that all panels contain a unit root. The alternative is that at least one panel is stationary.

Appendix 8. Fiscal reaction function results

Table 8.1. Fiscal policy reaction function: GLS coefficient estimates, CEE-10, 1995-2008

Dependent variable : pb_{it}					
	(1)	(2)	(3)	(4)	(5)
$pb_{i,t-1}$	**0.2294** **(0.1)**	**0.1774*** **(0.099)**	**0.2093*** **(0.0953)**	**0.2316**** **(1.2302)**	**0.2332**** **(0.1018)**
$d_{i,t-1}$	0.0543 (0.0479)	-0.0006 (0.0477)	0.0503 (0.0466)	0.0589 (0.05256)	0.062 (0.0488)
$d^2{}_{i,t-1}$	-0.0001 (0.0005)	9.25E-05 (0.0004)	-0.0001 (0.0004)	0.0002 (0.0005)	-0.0002 (0.0005)
gap_{it}	**0.1281***** **(0.0119)**	**0.1616***** **(0.0186)**	**0.1293***** **(0.0141)**	**0.1262***** **(0.0129)**	**0.1197***** **(0.0138)**
$hcpi_{it}$	**-0.0362***** **(0.008)**	0.0007 (0.0157)	**-0.0666***** **(0.0199)**	**-0.0516***** **(0.0088)**	**-0.0392***** **(0.0082)**
ca_{it}	**-0.0603*** **(0.0593)**	-0.0274 (0.0295)	-0.0389 (0.0297)	**-0.0745**** **(0.0355)**	**-0.0658**** **(0.0275)**
int_{it}		**0.8227**** **(0.3211)**			
odr_{it}			**0.4212*** **(0.229)**		
fri_{it}				**1.4787***** **(0.4561)**	
$D^{elec}{}_{it}$					-0.2173 (0.2443)
Const	0.1727 (1.1086)	**-2.4389*** **(1.4622)**	**-6.6673*** **(3.708)**	0.7657 (1.2302)	0.2912 (1.1315)
No. of observations	96	96	96	96	96
Adjusted R-squared	0.6788	0.7304	0.6666	0.7066	0.6816
Durbin-Watson stat	1.7783	1.802	1.8063	1.7832	1.7675
Redundant Fixed Effects Test	**3.4191****	**4.8995*****	**3.2842*****	**4.4283*****	**3.4715.*****

Note: The models include fixed effects dummies and are estimated using GLS cross-section weights and White cross-section coefficient-covariance method. Model 1 is the baseline model, while models 2 to 5 are extensions to the baseline. P-values are given in the parenthesis: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.

Table 8.2. Fiscal policy reaction function: GLS coefficient estimates, CEE-10, 2008-2015

	(1)	(2)	(3)	(4)	(5)	(6)
$pb_{i,t-1}$	**0.3623*** (0.0571)**	**0.3164*** (0.0587)**	**0.3674*** (0.0548)**	**0.3727*** (0.0598)**	**0.3573*** (0.0427)**	**0.343*** (0.0536)**
$d_{i,t-1}$	**0.1718*** (0.0457)**	**0.2207*** (0.0796)**	**0.172*** (0.0448)**	**0.1742*** (0.0399)**	**0.1626*** (0.0426)**	**0.1643*** (0.0415)**
$d^2{}_{i,t-1}$	**-0.001* (0.0006)**	-0.0009 (0.0009)	**-0.001* (0.0006)**	**-0.001* (0.0006)**	**-0.0008* (0.0005)**	**-0.0009* (0.0006)**
gap_{it}	0.067 (0.0872)	0.0508 (0.0877)	0.0759 (0.1022)	0.0738 (0.0992)	0.1287 (0.0834)	0.0854 (0.0828)
$hcpi_{it}$	**0.194*** (0.0204)**	**0.1444*** (0.0277)**	**0.2019*** (0.0249)**	**0.1884*** (0.0177)**	**0.2468*** (0.0395)**	**0.1884*** (0.0216)**
ca_{it}	**-0.2329*** (0.0096)**	**-0.1632*** (0.0226)**	**-0.2295*** (0.0134)**	**-0.2227*** (0.0176)**	**-0.1601*** (0.0239)**	**-0.2286*** (0.0113)**
int_{it}		**-1.8875** (0.8386)**				
odr_{it}			-0.0845 (0.2348)			
fri_{it}				-0.0451 (0.1716)		
ump					**0.3857* (0.2084)**	
$D^{elec}{}_{it}$						-0.3917 (0.3776)
Const	**-24.558*** (2.6592)**	**-18.635*** (2.2353)**	**-23.259*** (5.4416)**	**-24.01606*** (2.4629)**	**-29.299*** (3.0104)**	**-23.753*** (2.9368)**
No. of observations	80	80	80	80	80	80
Adjusted R-squared	0.8069	0.7609	0.804	0.7891	0.8181	0.8466
Durbin-Watson stat	2.4905	2.4395	2.4933	2.4889	2.5078	2.4913
Redundant Fixed Effects Test	**5.1556***	**4.1718***	**4.1108***	**4.8364***	**6.0128***	**5.1104***

Note: The models include fixed effects dummies and are estimated using GLS cross-section weights and White cross-section coefficient-covariance method. Model 1 is the baseline model, while models 2 to 6 are extensions to the baseline. P-values are given in the parenthesis: *** p<0.01, ** p<0.05, * p<0.1: variable is statistically significant at the 1%, 5% and 10%, respectively. Source: own calculation.

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