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Fiscal Reaction Functions for European Union Countries

Katia Berti, Eugeniu Colesnic, Cyril Desponts, Stéphanie Pamies and Etienne Sail

Abstract

This paper estimates country-specific fiscal reaction functions (FRFs) for selected European countries and tests for a change in fiscal behaviour since the beginning of the economic and financial crisis. The estimated country-specific FRFs, as well as a panel FRF for Central and Eastern European countries, are used in medium-term projections of the public debt-to-GDP ratio. Additional results in terms of fiscal risk assessment based on this FRF debt projection scenario and on the degree of realism of fiscal projections underlying public debt projections are also derived. Most EU countries are found to positively adjust their fiscal policy to rising levels of public debt, although to a weak extent in some cases. Since 2009, fiscal responsiveness to public debt appears to have generally increased over the sub-sample of EU countries considered. When using FRFs to project public debt ratios, results are on average less favourable than under the standard baseline no-fiscal policy change scenario used by the Commission services. However, for most countries, results generally corroborate the summary medium-term sustainability risk assessment made by the European Commission services (2016) based on more traditional debt projection scenarios and sensitivity tests. The paper also identifies a set of countries that are potentially at risk of fiscal fatigue.

JEL Classification: C22, C23, E62, H68.

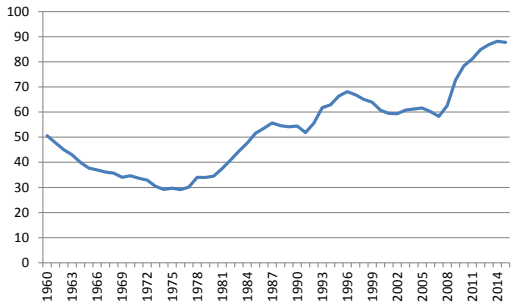
Keywords: debt sustainability, fiscal reaction function (FRF), public debt projection, fiscal fatigue, error-correction model, panel regression.

Contact: Katia Berti, team leader – economist, katia.berti@ec.europa.eu; Stéphanie Pamies, economist, stephanie.pamies@ec.europa.eu; Eugeniu Colesnic, statistical assistant, Fiscal Policy and Policy Mix Directorate of the European Commission's Directorate General for Economic and Financial Affairs. Etienne Sail contributed to this work while he was a statistical assistant in the same Directorate and Cyril Desponts contributed to this work while he was a trainee in the same Directorate.

1. INTRODUCTION

Public debt has reached historically high levels in the EU following the financial and economic crisis that started in 2008. The crisis led to severe sovereign debt sustainability concerns in several euro area countries in 2010-12 and resulted more generally in a sizeable increase of public debt ratios in the EU (see Graph 1). For the EU, gross public debt raised by 30 pps. of GDP between 2007 and 2015, with the highest increases ranging from around 45 pps. of GDP in the UK to more than 70 pps. of GDP in Ireland and Greece (see Graph 2), often in line with acute banking sector difficulties experienced in these countries. ([1]) Public debt in the EU raised from right below the EU Treaty reference value of 60% of GDP in 2007 to well above it (around 88% of GDP) in 2015, reaching unprecedented levels since WWII. More specifically, 17 EU countries had a gross public debt greater than 60% of GDP in 2015 (against 9 at the onset of the crisis), and in 8 cases the public debt ratio was above 90%.

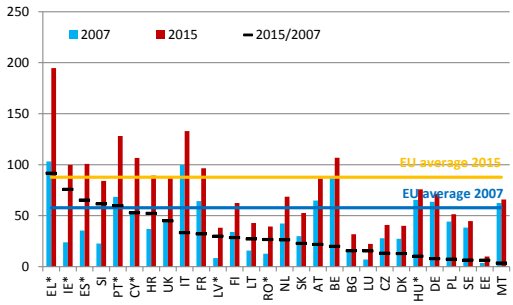
Graph 1: **EU* public debt (% of GDP)**



*EU28 as from 1995; smaller sub-set before 1995.

Source: AMECO, IMF (database from Mauro *et al*, 2013).

Graph 2: **Public debt ratio in 2007 and 2015, by country (ordered from highest increase to lowest increase through the period)**



*Countries that benefited from financial assistance (BoP facility or EFSM / EFSF / ESM).

Source: AMECO.

A two-folded policy response has been adopted during the crisis. Most Member States undertook sizeable fiscal consolidation between 2011 and 2013 to respond to rapidly increasing public debt levels and financial market pressure. In order to provide financial assistance when needed and to help preventing future sovereign debt crises, new assistance, as well as supervisory mechanisms were set up in the EU (e.g. the European Stability Mechanism, the Single Supervisory Mechanism). The EU also strongly renovated its macro-fiscal surveillance framework (through the reform of the Stability and Growth Pact, and the introduction of the Macroeconomic Imbalance Procedure). After the peak of the crisis, the challenges posed by contemporaneously high debt levels in the public and the private sector in a number of EU countries, and the current macroeconomic context of very low inflation, together with subdued GDP growth, have called for a more flexible and tailored fiscal consolidation approach. ([2]) Sustainable public finances nonetheless remain a key ingredient to ensure that EU countries have sufficient fiscal space to cope with adverse macroeconomic developments over the economic cycle and are sheltered from the risk of losing financial market access in the future. Smaller public debt burdens are also necessary to support long-term growth ([3]) and to meet future projected increases in age-related public spending (see European Commission, 2015).

From a methodological point of view, the focus put on debt sustainability analysis (DSA) in the context of the crisis has led to the enhancement of DSA frameworks used by international organisations. Taking stock of the euro area experience and the expanding literature on sovereign debt risks, both the European Commission and

([1]) See Eurostat figures on the impact of the financial crisis (due to banking bailouts) on public finances (http://ec.europa.eu/eurostat/web/government-finance-statistics/excessive-deficit/supplemtary-tables-financial-crisis).

([2]) The European Commission Communication on the best use of the flexibility embedded in the Stability and Growth Pact, issued early 2015, formalised the necessary balance to be achieved between sustainable and growth-supportive fiscal policies.

([3]) If an array of studies support the negative association between high levels of public debt and lower GDP growth, it is however not possible to determine the precise relationship between the two, including identifying a universal threshold beyond which debt becomes problematic (see European Commission, 2016).

the IMF have strengthened their respective DSA frameworks over the last few years (IMF, 2013; European Commission, 2016, 2014). In particular, a greater attention has been put on: i) the importance of governments' contingent liabilities (particularly from the banking sector); ii) the structure of public debt financing; iii) the design of enriched sensitivity scenarios, including the additional use of stochastic debt projections as a complementary tool to standard deterministic projections. Feedback effects of fiscal consolidation on growth incorporated in standard debt projections have also been revised in line with the more recent evidence on the larger size of fiscal multipliers in junctures of weak economic growth and zero lower bound (ZLB) conditions for monetary policy.

One aspect that remained to be accounted for in an accurate way in the Commission's DSA framework was the design of debt projections mirroring (country-specific, to the extent possible) fiscal policy responsiveness to public debt and macroeconomic conditions. While simple historical scenarios assuming gradual convergence of underlying macro-fiscal assumptions to historical average were already part of the toolkit, no single scenario was run incorporating an estimated coefficient of fiscal policy responsiveness. Such estimated coefficient could in fact also make it possible to think of an alternative definition of a no-fiscal policy change scenario, whereby *the responsiveness* of fiscal policy to debt and macroeconomic conditions remains unchanged (as opposed to the assumption of a constant fiscal stance, as in the more traditional definition of no-fiscal policy change used in baseline Commission projections). ([4])

In the economic debate, the optimal degree of fiscal policy responsiveness to rising public debt and changing macroeconomic conditions is still subject to intense discussion and diverging views. Fiscal consolidation in case of a rapidly increasing public debt level can clearly be welcomed as a way to restore fiscal sustainability, in line with the literature on fiscal reaction functions (initiated by Bohn, 1998). Others, however, point to the risks of dampening economic activity, in particular in contexts where a fragile recovery is on the way, and of facing *fiscal fatigue* (Gosh *et al*, 2013, 2011), especially when large and sustained fiscal consolidation appears to be required to ensure sustainability (see Eichengreen and Panizza, 2014). The question here relates more generally to the definition of an appropriate public debt-reduction strategy, in which fiscal consolidation plays an important role but must be carefully designed to avoid triggering detrimental effects on growth and self-defeating dynamics for the debt ratio. A debt projection scenario incorporating an estimated fiscal reaction function can most usefully serve the purpose of capturing some of these aspects in a country's DSA, by modelling in a more precise way the changes in fiscal policy associated with changes in the debt level and the macroeconomic context. In the Commission services' DSA framework, such a scenario was deemed to represent a particularly useful complement to the traditional (baseline) no-fiscal policy change scenario and the Stability and Growth Pact scenario (which assumes full respect of EDP recommendations and convergence of the government structural balance to the medium-term objective, as from the preventive arm of the Pact).

This paper therefore contributes to the existing fiscal reaction function (FRF) literature in the context of EU countries. In particular, it aims at tackling the following questions: based on historical data, does fiscal policy in EU Member States tend to react to a sufficient extent to increasing public debt or less supportive macro-financial conditions to ensure fiscal sustainability? Given the major changes in the financial and institutional setup since the crisis erupted (increased awareness of the risk of sudden changes in international investors' perceptions; renovated fiscal surveillance framework in the EU), has fiscal responsiveness to public debt increased? On the contrary, are there risks of *fiscal fatigue* given protracted fiscal consolidation in some EU countries? When fiscal behaviour is taken into account, as compared to a conventional no-fiscal policy change scenario, is the medium-term risk assessment modified? Finally, can this analysis be used to identify countries with remaining fiscal space in the EU?

The rest of the paper is organised as follows. Section 2 provides a summary of the literature on FRFs. Section 3 presents the methodology and the data used. Section 4 describes the estimation results, and Section 5 discusses debt projection results, debt sustainability thresholds and fiscal risk assessments using the estimated FRFs. Additional robustness checks are reported in annex to the paper.

([4]) In the Commission services' DSA, the baseline no-fiscal policy change scenario is based on a primary balance (excluding cyclical effects and projected implicit liabilities related to population ageing) that is set constant at its last Commission forecast value beyond the forecast horizon.

2. LITERATURE REVIEW

How can fiscal reaction functions (FRFs) be used in fiscal sustainability analysis? In the context of the 2010-12 European sovereign debt crisis and the general upward trend of public debt in OECD countries, the literature on FRFs has substantially grown since the seminal work of Bohn (1998). Indeed, FRFs, capturing the reaction of fiscal policy (in terms of the government's primary balance) to public debt and macroeconomic conditions, are regarded as a useful element in the toolkit for fiscal sustainability analysis. In Bohn and subsequent papers, FRFs are used to define and test fiscal sustainability. According to Bohn (1998, 2005), a positive and significant debt coefficient (γ in equation (1)) is a sufficient condition to ensure that the inter-temporal budget constraint (2) is satisfied: ([5])

$$pb_t = \gamma . d_{t-1} + \omega_t \quad (1)$$

$$d^* = \frac{1+g_t}{i_t - g_t} . pb_t \quad (2)$$

where pb_t is the primary balance as a percentage of GDP; d_{t-1} is public debt as a percentage of GDP; d^* is the level of the debt ratio consistent with debt sustainability; ω_t is a set of control variables; i_t is the interest rate and g_t is the GDP growth rate.

More recent papers (e.g. Fournier and Fall, 2015; Gosh *et al*, 2013, 2011) have questioned the aforementioned fiscal sustainability condition in the context of analytical frameworks that integrate FRFs with financial markets' reactions. They showed that the size of the debt coefficient in the FRF must be large enough to ensure that public debt will remain on a sustainable path. ([6])

While drawing strong conclusions on fiscal sustainability based on the sole debt coefficient is debatable, ([7]) FRFs can conveniently be used to perform alternative debt projections to the traditional no-fiscal policy change scenario (where the primary balance is simply held constant at its last forecast-year value), as anticipated in the introduction to the paper. ([8]) There are a number of papers that present stochastic debt projections integrating such behavioural equations (e.g. Lukkezen and Rojas-Romagosa, 2013, 2012; Medeiros, 2012; Burger *et al*, 2011; Celasun *et al*, 2007). ([9]) In recent contributions, FRFs have also been used for the estimation of public debt sustainability thresholds and public debt limits aimed at providing possible measures of fiscal space (e.g. Fournier and Fall, 2015; Gosh *et al*, 2013, 2011; European Commission, 2011). Finally, Checherita-Westphal and Ždarek (2015) also propose to use FRFs to derive primary balance benchmarks used to identify fiscal fatigue risks.

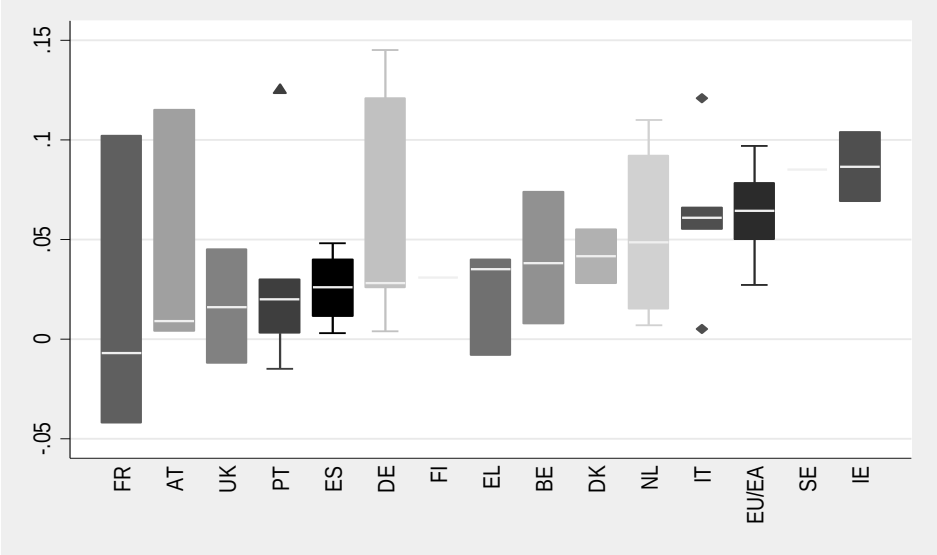
Accurately specifying the link between the primary balance and debt has been a crucial objective of the FRF literature. While the basic specification of FRFs is relatively straightforward (see (1)), a great attention has been put in the literature on accurately modelling the nature of the relationship between the primary balance and public debt. Initially specified as simple linear functions of debt, FRFs have then more frequently been estimated using non-linear 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). Such debt level dependent specifications aim at capturing thresholds, beyond which fiscal responsiveness would increase (lower threshold) and beyond which, on the contrary, *fiscal fatigue* ([10]) may set in (upper threshold). Recent papers have tried to derive such debt thresholds endogenously (Fournier and Fall, 2015; Legrenzi and Milas, 2013) on the basis of regime-switching models. Other approaches have enabled time-varying debt coefficients using state-space modelling (Burger *et al*, 2011) or penalized spline estimates (Fincke and Greiner, 2012, 2011).

([5]) See Bohn (1998, 2005) for a formal proof.
([6]) Moreover, as reminded in Checherita-Westphal and Ždarek (2015), a positive FRF debt coefficient cannot be viewed as a sufficient condition for sustainability if there is a limit for positive values of primary balances.
([7]) This is debatable also because in practice estimated debt coefficients can vary substantially depending on the time period considered.
([8]) See European Commission, 2016.
([9]) FRFs are typically not introduced in standard DSA frameworks (as in the IMF's), but instead considered in enhanced / tailored-made DSAs.
([10]) This reflects the idea that, at high levels of public debt, fiscal responsiveness would weaken, and could even turn negative at very high levels.

Checherita-Westphal and Ždarek (2015), as well as Weichenrieder and Zimmer (2014), also test whether fiscal responsiveness has changed in Member States since the launch of EMU by interacting the debt variable with a time-dummy. Mauro *et al* (2013) interact debt variables with macro-financial variables to determine if fiscal prudence/profligacy is influenced by macroeconomic conditions and financial market pressure. Finally, several papers using more recent data investigate the issue of whether governments' primary balances have become more responsive to debt since the onset of the 2009 financial crisis (Baldi and Staehr, 2015; Checherita-Westphal and Ždarek, 2015).

The FRF literature is relatively heterogeneous in terms of adopted empirical approach. A question raised by the FRF literature relates to whether *country-specific* FRFs, relying on long time series, should be preferred or, instead, a greater attention should be put on the *time-consistency* dimension, thus estimating a single FRF over a panel of countries and a shorter time period. Country-specific FRFs indeed capture the country specificities inherent to fiscal behaviour, but they traditionally need to rely on very long time periods, ([11]) encompassing (very) different macroeconomic conditions. Thus, assuming a *time-invariant* fiscal behaviour (in relation to debt and other variables) may be seen as a strong hypothesis. ([12]) On the other hand, a single FRF estimated over a panel of countries and a shorter time frame presupposes *country-invariant* fiscal behaviour across the sample of countries considered, which may prove an even stronger assumption. ([13]) This is in particular highlighted by Weichenrieder and Zimmer (2014), which show that panel data results can be sensitive to the exclusion of some countries, especially when aiming at putting into evidence time-varying debt coefficients. ([14])

Graph 3: **Estimated debt coefficients across selected country-specific studies (ranging from lowest to highest median value)**



(1) In this graph, each box plot is a representation of the distribution of the debt coefficient estimated over the sample of studies considered (by country). The middle line (in white) represents the median value, the top and bottom of the box correspond to the 75th and 25th percentile values; the top and bottom branches represent the upper / lower adjacent values; finally, the dots correspond to outside values. The longer the box (and branches) is, the wider the dispersion of the estimated coefficients is. For example, for Italy, the median of the estimated debt coefficient over the studies considered is at 0.06, with 2 outside values of 0.12 and 0.005.

Source: Schoder (2014), Legrenzi and Milas (2013), Mauro et al (2013), Lukkezen and Rojas-Romagosa (2013, 2012), Fincke and Greiner (2012, 2011), Piergallini and Postigliola (2012).

Studies tend to find evidence of a positive and significant fiscal reaction to increasing debt, with important country- and time-variability though. Based on a relatively extensive literature review, Checherita-Westphal

([11]) FRFs are generally based on annual data (since fiscal data at a higher frequency are considered as less meaningful). There are a few studies that use quarterly data though (see Table 1 for recent references).

([12]) A counter-argument, based on Reinhart *et al* (2003), could be the existence of a form of inertia in fiscal behaviour, illustrated by the fact that countries found to have defaulted in the past (sometimes in the very long past) are more likely to still exhibit fiscal weaknesses in the present (in relationship with structural country-characteristics such as economic specialization or the quality of political institutions).

([13]) Even if country-fixed effects are typically taken into account.

([14]) See Section 3 for more elements on differences in empirical approaches used in the literature.

and Ždarek (2015) found that the intensity of the reaction to debt generally varies between 0.01 and 0.10. On a selected range of recent panel data studies that focus on the EU/EA (see Table 1), this coefficient is estimated between 0.03 (European Commission, 2011) and 0.10 (Baldi and Staehr, 2015, based on post-crisis data). Looking at country-specific papers, results appear more mixed. Several studies point to a non-significant (or negative) debt coefficient in some cases (e.g. France, Spain or Portugal in the studies considered, except for Fincke and Greiner, 2012), while other countries would exhibit strong fiscal responsiveness to debt (e.g. Ireland and Sweden). However, a high variability of estimations emerges across individual countries' studies (see Graph 3), with the highest standard deviation found for France and Germany.

Some papers point to the risk of fiscal fatigue, while others find evidence of an increased fiscal responsiveness in the EU since the 2009 financial crisis. Several papers provide evidence of a fiscal fatigue phenomenon (e.g. Fournier and Fall, 2015; Gosh *et al*, 2013, 2011; Medeiros, 2012). ([15]) According to Gosh *et al* (2013, 2011) and Medeiros (2012), fiscal responsiveness to debt would start to weaken above a threshold of around 80 – 100% of GDP, and would become negative above around 150% of GDP. Fournier and Fall (2015) find even higher thresholds (either considering OECD / EA countries only and including post-crisis data or not) of respectively 120% - 150% of GDP and 170% of GDP. However, other authors challenge this finding, pointing, on the contrary, to an increased fiscal responsiveness to debt since the financial crisis (e.g. Baldi and Staehr, 2015; Checherita-Westphal and Zdarek, 2015). Baldi and Staehr (2015) find that fiscal responsiveness in the EU increased from 0.05 (over 2001 – 2008) to close to 0.10 (over 2009 – 2014) based on quarterly data. Checherita-Westphal and Ždarek (2015) also point to an increase in fiscal prudence since the crisis but to a lower extent (the intensity of the fiscal response being reduced from 0.05 to less than 0.04 when excluding crisis years). Finally, some earlier papers (using pre-crisis data) fail to find a non-linear response of primary balance to debt (e.g. European Commission, 2011, and Mendoza and Ostry, 2007).

([15]) Another stream of the literature, based on empirical historical and cross-country analysis, also pointed to such a risk (e.g. Eichengreen and Panizza, 2014).

Table 1: **Selected recent papers on fiscal reaction functions for EU countries**

Paper	Geographic and data coverage (and frequency)	Type of econometric technique	Form of the relationship between PB and debt	Main results (debt coefficient)	Output
Baldi and Staehr (2015)	27 EU countries; 2001 / 2009 - 2008 / 2014; quarterly data	Panel-data analysis (over groups of similar countries according to objective criteria)	Linear function	Debt coefficient = 0.05 before the crisis and 0.10 since the crisis	-
Checherita-Westphal and Žďarek (2015)	18 EA countries; 1970 – 2013; annual data	Panel-data analysis	Linear and non-linear function (polynomial function; interaction term for EMU period)	Debt coefficient = 0.05 (benchmark regression); increased debt coefficient since EMU (+0.02) and since the crisis (+0.01); weak signs of fiscal fatigue (above 115 - 120% of GDP)	Benchmark primary balance (PB) to be used to assess realism of PB projections in DSA
Fournier and Fall (2015)	31 OECD countries; 1985-2007 / 2013; annual data	Panel-data analysis	Non-linear function (endogenous threshold)	Debt coefficient = 0.02 (for debt level below around 120% of GDP), 0.06 (for debt level above 120% of GDP but below around 170% of GDP), and -0.1 (for debt level above 170% of GDP)	Public debt limits and fiscal space
Schoder (2014)	15 OECD countries;1980-2010 (1980 – 1996; 1997 – 2010); quarterly data	Time-series analysis (ECM) and panel-data analysis	Linear function	Debt coefficient only significant for 2 countries (BE and DK); when data pooled over EMU countries, debt coefficient = 0.03; no increase in debt coefficient since EMU	-
Weichenrieder and Zimmer (2014)	EA countries; 1970 – 2008 / 2011; annual data	Panel-data analysis	Linear and non-linear function (interaction terms for Maastricht and EMU periods)	Debt coefficient = 0.06 (reduced by -0.02 but still positive since EMU); results sensitive to the exclusion of one country (especially EL) and the exclusion of crisis years	-
Gosh *et al* (2013, 2011)	23 advanced economies (including euro area); 1970 / 1985 -2007; annual data	Panel-data analysis	Non-linear function (polynomial function)	Results show signs of fiscal fatigue (debt coefficient turning negative for debt level beyond 150% of GDP)	Public debt limits and fiscal space
Legrenzi and Milas (2013)	Greece, Ireland, Portugal and Spain; 1960 (1970) – 2012; annual data	Time-series analysis (ECM) with regime-switching behaviour	Non-linear function (endogenous threshold)	Debt coefficient = from 0.02 for ES to 0.10 for IE; 4 countries adjust PB to rising debt only when debt level is above a certain threshold (around 45% of GDP for IE, PT and ES and around 70% of GDP for EL)	-

Paper	Geographic and data coverage (and frequency)	Type of econometric technique	Form of the relationship between PB and debt	Main results (debt coefficient)	Output
Lukkezen and Rojas-Romagosa (2013, 2012)	9 OECD countries (US, UK, NL, BE, DE, IT, ES, PT and IS) including 7 EU countries; at the best, since 1691 (but main estimations use only post-WWII data) - until 2011 (at the best); annual data	Time-series analysis (level)	Non-linear function (conventional threshold)	Debt coefficient = from 0.03 in DE to 0.07 in NL (out of EU countries); not significant in ES and PT with signs of fiscal fatigue in these 2 countries	Stochastic debt projections. Conclude that in the case of ES and PT, there are doubts about debt sustainability.
Mauro *et al* (2013)	42 countries (advanced and emerging economies); at the most 202 observations for a country; until 2011 (at the best); annual data	Time-series analysis and panel-data analysis	Linear and non-linear function (some specifications with interaction terms between explanatory variables - e. g. debt and growth)	Debt coefficient = 0.02 over all panel and period 1950 – 2011; this link would be weakened in case of slower growth and increased in case of greater financial market pressure; country-specific estimates show coefficient ranging from -0.04 for FR to 0.09 for SE (out of EU countries); not significant for PT, FI and AT	-
Fincke and Greiner (2012)	Austria, France, Germany, Italy, the Netherlands, Portugal; mid 70's – 2005 / 2006; annual data	Time-series analysis (penalized spline estimation)	Non-linear function (time-varying coefficients)	Debt coefficient = from 0.10 for FR to 0.15 for DE	-
Medeiros (2012)	EU countries; 1976 / 1990 to 2009 / 2011; quarterly data	Panel-data analysis (level and first difference)	Linear and non-linear function (polynomial function)	Debt coefficient = 0.08 (benchmark regression); results confirm the existence of fiscal fatigue above a debt ratio of around 90 to 100% of GDP	Stochastic debt projections
Piergallini and Postigliola (2012)	Italy; 1861-2009; annual data	Time-series analysis (including VAR)	Linear function	Debt coefficient = 0.06 (over the period 1948 – 2009); VAR analysis yields similar results	-
European Commission (2011)	EU27; 1975 – 2010; annual data	Panel-data analysis	Linear function	Debt coefficient = 0.03 (benchmark regression)	Debt sustainability thresholds
Fincke and Greiner (2011)	Japan, Germany and US; 1961 – 2006 for Germany; annual data	Time-series analysis (penalized spline estimation)	Non-linear function (time-varying coefficients)	Overall debt coefficient for Germany = 0.12 (significant only at 10%); magnitude decreasing through time (going to negative values)	-

3. METHODOLOGY AND DATA USED

In this paper we estimate country-specific FRFs for EU countries, whenever long time series are available (this is the case for 13 countries, namely Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Netherlands, Austria, Portugal, Finland, Sweden and the UK). For Central and Eastern European countries (CEECs, including Bulgaria, Czech Republic, Estonia, Croatia, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia), for which data availability is more limited, a panel FRF has been estimated. ([16]) The main aim is to use these country-specific and panel FRFs in a FRF scenario for public debt projections in the context of the European Commission services' DSA (see European Commission, 2016).

When estimating fiscal reaction functions, several choices need to be made in terms of specification and econometric approach. In terms of specification, the main question relates to the choice of control variables (ω_t in equation (1)). An output gap variable and an expenditure gap variable (the latter used to account for unexpected expenditures, unrelated to the economic cycle, such as military expenditures, for instance) are control variables commonly used in FRFs. Variables like the interest rate and inflation are also often included to account for financial market pressure and valorisation effects. 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 (average) relationship between public revenues (and spending) and GDP, with a strong increase in short-term fiscal multipliers. ([17]) In a number of cases, banking bailouts have also impacted public finances more acutely than measured through a standard expenditure gap variable. Hence, a crisis dummy will in most cases be introduced in the econometric specification to account for downward pressures on the primary balance. Furthermore, unprecedented levels of financial stress in some EU countries (captured by increasing market interest rates) ([18]) – not fully correlated to the economic cycle or fiscal variables – as well the reform of the EU fiscal surveillance framework are also likely to have affected fiscal behaviour in a more durable way, hence implying a structural break in the public debt - primary balance relationship.

In terms of econometric approach, estimating FRFs raises **stationarity** issues, especially for country-specific FRFs relying on long time series. In this case, key variables (public debt and potentially the primary balance) ought to be non-stationary, a result often found in the relevant literature. Surprisingly, however, relatively few papers deal with stationarity problems, for example by using error-correction models (this is the case in Schoder, 2014, Legrenzi and Milas, 2013, and Burger *et al*, 2011). This issue was nonetheless discussed in the seminal paper by Bohn (1998), which showed that standard unit root tests were particularly weak in the case of public debt, and that a positive and significant FRF debt coefficient was a sufficient condition to conclude that debt was sustainable. ([19])

Endogeneity problems need to be addressed when estimating FRFs, given the likely interactions between the variables entering the equation. For example, the output gap should be correlated to some extent with the primary balance (fiscal multiplier effect), while public debt could be correlated with the residuals (for example, to the extent that residuals are auto-correlated, a country able to generate high primary balances – due to unobserved factors captured in the residuals – will tend to have a lower public debt; thus, if this effect is not properly taken into account, the negative relation between debt and the residuals will create a downward bias on the estimated FRF coefficient on debt). This last source of endogeneity should be more important in the case of panel data analysis, where a common FRF is assumed, than with country-specific regressions (moreover, when

([16]) Results are not reported for Greece and Cyprus as these countries were under specific fiscal surveillance procedures in the context of macroeconomic adjustment programmes at the time of the completion of this work. No FRF was estimated for Luxembourg due to data limitations.

([17]) See Blanchard and Leigh (2013) on the increase of short-term fiscal multipliers especially at the onset of the financial crisis (in line with the presence of acute credit constraints). This effect is not fully captured by the output gap coefficient, nor by the expenditure gap variable (calculated over the period 1950 – 2013).

([18]) These effects are not fully captured by the implicit interest rate on debt, especially for countries with a high average debt maturity. Moreover, interest rate variables do not capture other (non-price) credit constraints.

([19]) In Baldi and Staehr (2015), public debt is found to be I(1), but different specifications to account for non-stationarity issues yield similar results compared to a standard specification ignoring this problem. Burger *et al* (2011) estimate a VECM to take into account non-stationarity issues, but also obtain relatively similar results to standard OLS estimates in levels. Piergallini and Postigliola (2012) and Bohn (2005, 1998) conclude, on the basis of non-conventional unit root tests, that public debt is indeed stationary (i.e. sustainable). De Mello (2005) struggles to fully reject the unit root hypothesis, but estimates a traditional FRF anyway (in levels), and performs additionally ECM regressions (with public revenue as the dependent variable). Legrenzi and Milas (2013) find that both PB and debt are I(1) and estimate an ECM with satisfactory results. Schoder (2014) also relies on an ECM specification but in this case the (time-series) results are not very satisfactory (the long-run debt coefficient is almost always non-significant, and the author therefore has to resort to pool data, but this paper is among the few relying on quarterly data, which could explain the disappointing results).

variables are considered in first differences, which is the case with an error-correction model, this source of endogeneity should be reduced – see Medeiros, 2012).

3.1. COUNTRY-SPECIFIC FISCAL REACTION FUNCTIONS

Our country-specific FRFs follow an error-correction model (ECM) specification, similar to the one adopted in Legrenzi and Milas (2013), Schoder (2014) and Burger *et al* (2011). The general form of the regression model is the following:

$$\Delta PB_t = \alpha + \rho.(PB_{t-1} - a.Debt_{t-2} - b.Debt_{t-2}.crisis) + \beta.\Delta Debt_{t-1} + \gamma.\Delta Debt_{t-2} + \delta.GG_t + \varepsilon.YG_t + \theta.reff_t + \vartheta.infl_t + \mu.crisis_t + \epsilon_t \quad (3)$$

At each period of time *t*, primary balance variations (ΔPB_t) are explained by two components: 1) the error-correction component, capturing the fraction (ρ) of the deviation from the long-term relationship ($PB_{t-1} - a.Debt_{t-2} - b.Debt_{t-2}.crisis$) that is adjusted every year; 2) short-term variations of lagged public debt ($\Delta Debt_{t-i}$), the expenditure gap (GG_t), the output gap (YG_t), the real implicit interest rate ($reff_t$) and the inflation rate ($infl_t$). Unit root tests suggest that public debt is generally I(1), and the primary balance is too in about half of the cases, while other variables are generally found to be stationary, thus entering the short-term part of the equation in levels (results are reported in Annex 2). ([20])

The expenditure gap is defined as the deviation between current and trend public primary expenditure (see Annex 1 for more details). The $crisis$ dummy captures the negative impact of the crisis on the primary balance that is not captured by other variables (i.e. expenditure gap; output gap; real implicit interest rate, which imperfectly captures financial market tensions). ([21]) We also allow for a structural break in the long-term relationship between primary balance and public debt by adding an interaction term between lagged public debt and the crisis dummy ($Debt_{t-2}.crisis$), similarly to what done in Weichenrieder and Zimmer (2014) (in their case for testing for the effect of the introduction of the euro on fiscal responsiveness). ([22])

Model (3) is estimated for 13 EU countries, which were not under a macro-financial assistance programme when completing this work and for which sufficiently long time series were available (Belgium, Denmark, Germany, Ireland, Spain, France, Italy, Netherlands, Austria, Portugal, Finland, Sweden and the UK). The estimation period generally covers the years 1950-2013.

Equation (3) is estimated in one-step using Banerjee *et al* (1998) methodology. This relatively simple approach is preferred to more advanced econometric techniques (such as the estimation of a VECM based on the methodology by Johansen, 1995, or the ARDL bounds testing approach used in Schoder, 2014), ([23]) given the specific aim of the exercise, i.e. integrating the estimated equations in the Commission services' deterministic debt projection model for EU countries, ([24]) which requires relatively simple equations, as homogenous as possible over all EU countries considered. Finally, the estimations are performed using Newey – West correction to allow for heteroskedasticity- and autocorrelation-consistent standard errors.

3.2. PANEL FISCAL REACTION FUNCTION FOR CENTRAL AND EASTERN EUROPEAN COUNTRIES

For Central and Eastern European countries (CEECs), a single FRF is estimated using panel data techniques. The econometric specification used is the following:

$$PB_{it} = \alpha + \beta.PB_{it-1} + \gamma.Debt_{it-1} + \delta.GG_{it} + \varepsilon.infl_{it} + \theta_i + \epsilon_{it} \quad (4)$$

([20]) Keele and De Boef (2004) show the advantages of using an ECM approach also for stationary variables.
([21]) The *crisis* dummy takes value 1 as from 2009.
([22]) Alternatively, a polynomial function was also tested, but seemed appropriate only for about half of the countries considered. Furthermore, the evidence of fiscal fatigue was found to be based on a very limited number of observations in some cases.
([23]) This last approach, which requires introducing extended lag length of the variables entering the FRF, may also seem less appealing in the context of a limited sample size (especially when we want to introduce several macroeconomic variables in the econometric specification).
([24]) The European Commission services' DSA framework is presented in European Commission (2014).

where GG_{it} is the expenditure gap (defined as in the previous section); $infl_{it}$ is the 3-year moving average of the inflation rate and θ_i is an unobserved country fixed effect. This specification incorporating the lagged primary balance on the right-hand side was preferred based on the strong evidence of persistence for the primary balance variable in all alternative specifications and using various estimators. Other variables like the output gap and the interest rate have been excluded from our panel FRF as not statistically significant. The crisis dummy also turned out to be not statistically significant for this panel of CEECs. ([25])

The panel consists of 12 countries (Bulgaria, Czech Republic, Estonia, Croatia, Latvia, Lithuania, Hungary, Malta, Poland, Romania, Slovenia and Slovakia) and 20 years at best, starting from the mid-1990s (unbalanced panel). Given the small sample size (198 observations), we estimate the panel FRF on the whole sample of countries, without differentiating among sub-groups of relatively more homogeneous countries. ([26])

We choose the GMM estimator (the one-step difference, Arellano Bond, GMM estimator, instrumenting for the lagged primary balance and lagged debt ratio) ([27]) as our preferred option to obtain the estimates for equation (4) for use in our public debt projection FRF scenario. ([28]) We checked the robustness of the results to the use of different estimation methods (which is particularly important in this case given the small sample size). The variables used in specification (4) remain all highly statistically significant under different estimation techniques. The signs of the estimated coefficients are consistent across estimation methods and in line with expectations, as shown in Section 4.2.

3.3. THE DATASET

The dataset used is constructed mainly using data from the European Commission – Directorate General for Economic and Financial Affairs' annual macroeconomic database (AMECO) and the Historical Public Finance Database (HPFD) built by Mauro *et al* (2013). Data from the two sources have been integrated in a way to ensure source-consistency across fiscal variables (i.e. for every point in time, we ensure that fiscal variables come from the same database – see Annex 1 for more details). For values of the GDP growth rate and inflation far back in time, Maddison (GDP) and Reinhart and Rogoff (inflation) databases have been used (see Annex 1).

For country-specific FRFs, the estimations are obtained using series generally covering the period 1950 – 2013, while, for the single FRF over the panel of CEECs, the time-period of reference is from the mid-1990s to 2013.

4. MAIN RESULTS

4.1. COUNTRY-SPECIFIC FISCAL REACTION FUNCTIONS

Fiscal responsiveness would appear to have increased since the 2009 crisis in some EU countries. Estimation results show that, over the whole estimation period, the highest long-term FRF debt coefficient is found for Finland and Belgium (at 0.10–0.11), meaning that, based on long-term historical behaviour, these two countries tend to significantly adjust their primary balance to changes in the public debt level (see bottom of Tables 2 and 3 below). Compared to the existing literature (see Section 2), the intensity of the reaction for these two countries appears to be on the high side. On the other hand, this long-term FRF debt coefficient appears not to be significant in the case of Germany, Italy, Austria, the UK and Portugal, and slightly negative for France. These

([25]) Other variables that have been tried and excluded from the regression model as not statistically significant are: the current account, a quadratic term for the debt ratio, the European Commission Fiscal Rules Index, a dummy for the legislative electoral year to capture the impact of the political cycle.

([26]) A further differentiation among sub-groups of Central and Eastern European countries (countries with limited versus substantial fiscal problems) to the purpose of estimating FRFs is done, for instance, in Baldi and Staehr (2013) but relying on quarterly data, not on annual data as we do.

([27]) We restrict the number of instruments to lags 2 and 3 of the instrumented variables. We checked the robustness of results to a reduction in the number of instruments (results are reported in Section 4.2).

([28]) As it is well-known that the instruments available for the equations in first differences are likely to be weak when the individual series have near unit root properties (in which case serious finite sample biases can arise), we tested for and did not find evidence of highly persistent time series in our sample.

results seem overall in line with the existing literature, except perhaps in the case of Italy. However, a strong FRF coefficient to short-term variations of public debt is found for this country (see Table 2).

When additionally interacting the debt variable with the crisis dummy, the long-term FRF debt coefficient (*a* + *b*) becomes positive and significant for all countries (see bottom of Tables 2 and 3). Thus, since the 2009 financial crisis, a substantial change in fiscal behaviour would have been registered for Germany, France, Italy, Austria, the UK, Portugal and Spain. For this group of countries, fiscal responsiveness to public debt appears to have become positive and significant (or to have increased). ([29]) The highest level is found for Italy (0.17). However, the sum of the debt coefficients (*a* + *b*) is only significant at the 10% level for France (as shown in the Wald test at the bottom of Table 2). These results are consistent with Baldi and Staehr (2015) and Checherita-Westphal and Ždarek (2015). ([30]), ([31])

Estimating a panel FRF for the 13 countries considered in this section also suggests an overall increase in fiscal response to debt since the financial crisis. ([32]) Nevertheless, it remains the fact that the result has to be considered cautiously given the limited number of crisis observations. ([33])

As expected, other things being equal, the primary balance responds negatively to an increase in the deviation between current and trend public expenditure in all 13 countries analysed. On the other hand, the output gap is only significant in two cases: Denmark (with a positive sign) and Ireland (with a negative sign, pointing to a pro-cyclical fiscal policy). ([34]) Inflation and the real implicit interest rate are statistically significant in a greater number of cases, with a positive sign in about half of the cases (Italy, the Netherlands, Finland and Portugal). ([35]) Finally, the crisis dummy is significant (with a negative coefficient) for most of the countries (except for Germany, the Netherlands and Sweden).

The statistical properties of the country-specific FRFs appear overall relatively satisfactory, as can be seen from the statistics displayed in Tables 2 and 3, in terms of goodness-of-fit, absence of auto-correlation and cointegration. ([36]), ([37])

([29]) One exception to this is the Netherlands, where fiscal responsiveness appears to have weakened since the crisis, as shown by the sum of the coefficients *a* and *b*, which becomes non-significantly different from 0 (see Wald test at the bottom of Table 2).

([30]) These two papers are based on panel data analysis.

([31]) In order to further test the robustness of our results on the FRF debt coefficient, equation (3) was re-estimated for all 13 countries including two additional observation points (2014 and 2015). Results show that extending the estimation period by two years would bring relatively small changes to the estimated long-term FRF debt coefficients with the only exception of Italy (reduced by 0.03). In the case of France, the sum of the whole period and crisis period FRF debt coefficient (*a* and *b*) would now be significantly different from 0 at the 5% level. In the case of BE, DK, FI, SE and IE, we would still reject the hypothesis of a structural break in the long-term FRF debt coefficient (the crisis period coefficient is still not significant at the 5% level). These additional estimation results can be provided, upon request, by the authors.

([32]) To the purpose of designing a FRF debt projection scenario, it was preferred, when possible, to estimate country-specific FRFs. Moreover, given the structural break in fiscal policy induced by the 2010-12 sovereign debt crisis, a change in the FRF debt coefficient was allowed (which proved relevant in 8 countries out of 13). However, the results obtained are necessarily based on a limited number of observations. Therefore, alternatively, equation (3) has been estimated over the panel of our 13 countries, using a simple fixed-effects model. Moreover, the equation was estimated with and without crisis years in order to assess if a change in fiscal behaviour could be confirmed. The results indicate that fiscal responsiveness would have increased since the financial crisis (with a long-run FRF debt coefficient increased from 0.04 to 0.11). The tables can be provided, upon request, by the authors.

([33]) For instance, in the case of Spain, the FRF debt coefficient appears quite high in the standard specification used. Therefore, an alternative specification, based on a simple regression in level, is also estimated.

([34]) To overcome potential endogeneity issues associated to the inclusion of the output gap in our country-specific FRFs, alternative regressions have been run using lagged values of the output gap (up to 2 lags) as instrumental variables (IV). However, in the majority of cases, the output gap would remain non-significant (even at 10%). In the case of Denmark and Ireland, it would remain significant and the value of the long-term FRF debt coefficient, as well as the output gap coefficient, would be relatively little changed. Only in the case of France, the use of IV would make a difference with the output gap becoming weakly significant (at 10%). However, given this relatively low level of significance, the fact that the general properties of the regression would not be improved, and that the output gap variable is not significant in most other countries, it was preferred not to use such an equation as our reference regression. These additional estimations can be provided, upon request, by the authors.

([35]) A negative sign is, however, found in other cases. For inflation, this would require further investigating indexation mechanisms and lags of tax bases.

([36]) Although, remaining autocorrelation in the residuals cannot be ruled out for some countries (BE, UK and IE).

([37]) Dynamic simulation results on the performance of the estimated FRFs are reported in Annex 3.

Table 2: **Country-specific FRFs – estimation results (dependent variable: ΔPB, period 1950-2013)**

VARIABLES	BE	DK	DE	FR	IT	NL	AT	FI	SE	UK
Constant	**-3.053*** **	**0.548*** **	**0.480** **	**0.514**	**-0.171**	**-1.814** **	**0.119**	**-2.526*** **	**-0.748**	**0.235**
	(0.906)	(0.200)	(0.203)	(0.354)	(0.131)	(0.681)	(0.166)	(0.416)	(0.587)	(0.249)
Δ Lagged debt	-	-	-	-	**0.0859** **	**-0.107*** **	-	-	-	-
					(0.0411)	(0.0322)				
Δ Lagged debt (-1)	-	-	-	**0.0758** **	-	-	**0.126*** **	-	-	-
				(0.0343)			(0.0462)			
Lagged primary balance	**-0.715*** **	**-0.650*** **	**-0.621*** **	**-0.514*** **	**-0.145** **	**-0.901*** **	**-0.555*** **	**-0.583*** **	**-0.626*** **	**-0.480*** **
	(0.102)	(0.0760)	(0.148)	(0.0740)	(0.0663)	(0.0822)	(0.0666)	(0.0680)	(0.0703)	(0.0911)
Lagged debt (-1) (a)	**0.0743*** **	**0.0364*** **	-	**-0.0178***	-	**0.0203** **	-	**0.0650*** **	**0.0509*** **	-
	(0.00988)	(0.00612)		(0.00949)		(0.00826)		(0.0119)	(0.0101)	
Lagged debt (-1) x Crisis (b)	-	-	**0.00939** **	**0.0341*** **	**0.0242*** **	**-0.0179** **	**0.0146***	-	-	**0.0495*** **
			(0.00393)	(0.00407)	(0.00398)	(0.00779)	(0.00807)			(0.0134)
Expenditure gap	**-0.379*** **	**-0.326*** **	**-0.622** **	**-0.425*** **	**-0.299** **	**-0.921*** **	**-0.466*** **	**-0.609*** **	**-0.680*** **	**-0.437*** **
	(0.125)	(0.0708)	(0.289)	(0.0915)	(0.134)	(0.0902)	(0.150)	(0.0950)	(0.103)	(0.121)
Output gap	-	**0.347*** **	-	-	-	-	-	-	-	-
		(0.0527)								
Inflation	**-0.399*** **	-	-	-	-	**0.228*** **	-	**0.322*** **	**-0.245*** **	-
	(0.102)					(0.0574)		(0.0416)	(0.0536)	
Real IIR	**-0.466*** **	-	-	-	**0.0761** **	**0.259*** **	-	**0.271*** **	-	-
	(0.0956)				(0.0346)	(0.0523)		(0.0398)		
Crisis	**-2.841*** **	**-1.638*** **	-	**-3.125*** **	**-2.294*** **	-	**-1.479*** **	**-1.363*** **	-	**-5.210*** **
	(0.471)	(0.299)		(0.399)	(0.383)		(0.494)	(0.428)		(0.533)
Dummy source PB	-	**3.300*** **	-	**1.212*** **	-	**1.456*** **	-	-	-	**3.788*** **
		(0.199)		(0.391)		(0.331)				(0.354)
Dummy source Debt	**1.315*** **	-	-	**-3.600*** **	**-1.640*** **	**-2.012*** **	-	-	**0.976** **	**-2.418*** **
	(0.487)			(0.293)	(0.295)	(0.340)			(0.472)	(0.350)
Observations	64	59	62	64	64	64	63	64	64	64
Adjusted R^2	0.552	0.677	0.459	0.586	0.295	0.793	0.634	0.621	0.651	0.513
ADF t-stat (residuals)	-3.631***	-7.160***	-6.760***	-6.479***	-7.940***	-6.454***	-6.871***	-8.265***	-7.047***	-6.049***
Breusch-Godfrey LM test χ^2 (prob.)	0.008	0.931	0.385	0.174	0.894	0.147	0.103	0.713	0.283	0.014

Standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1 (computed using heteroskedasticity- and autocorrelation-consistent standard errors with Newey-West lag window of size 3)

Long-term FRF debt coefficient	BE	DK	DE	FR	IT	NL	AT	FI	SE	UK
Whole period	0.104	0.056	-	-0.035	-	0.023	-	0.111	0.081	-
Since the crisis	0.104	0.056	0.015	0.032	0.167	0.003	0.026	0.111	0.081	0.103
Wald test (Chi-square, p-value)										
a + b	-	-	-	0.097	-	0.829	-	-	-	-

(1) Long-term FRF debt coefficients are derived as minus (-) the ratio between the estimated coefficient on lagged debt (-1) and the estimated error-correction term.

Source: Commission services.

Table 3: **Country-specific FRFs – estimation results (dependent variable: ΔPB, period 1950-2013)**

VARIABLES	IE	PT	ES (1)	ES (2)
Constant	**-3.041*** **	**-0.961*** **	**0.768*** **	**1.455** **
	(0.930)	(0.337)	(0.146)	(0.620)
Δ Lagged debt	-	-	-	-
Δ Lagged debt (-1)	**-0.133** **	-	-	-
	(0.0648)			
Lagged primary balance	**-0.823*** **	**-0.618*** **	**-0.386*** **	-
	(0.145)	(0.0963)	(0.113)	
Lagged debt (-1) (a)	**0.0630*** **	-	-	-
	(0.0141)			
Lagged debt (-1) x Crisis (b)	-	**0.0573*** **	**0.0930*** **	-
		(0.00396)	(0.0102)	
Lagged debt	-	-	-	**0.0419*** **
				(0.0145)
Lagged debt x crisis	-	-	-	**0.0617*** **
				(0.0180)
Expenditure gap	**-0.826*** **	**-0.377*** **	**-0.196*** **	**-0.130*** **
	(0.116)	(0.0662)	(0.0296)	(0.0467)
Output gap	**-0.170** **	-	-	-
	(0.0837)			
Inflation	**-0.100***	**0.0560** **	**-0.0929*** **	**-0.444*** **
	(0.0559)	(0.0278)	(0.0249)	(0.0564)
Real IIR	-	**0.0980** **	-	**-0.326*** **
		(0.0380)		(0.0430)
Crisis	**-4.966*** **	**-5.401*** **	**-7.140*** **	**-12.99*** **
	(1.268)	(0.379)	(0.463)	(0.886)
Dummy source PB	-	-	**-2.642*** **	**-2.385*** **
			(0.228)	(0.493)
Dummy source Debt	**-2.715*** **	-	-	-
	(0.691)			
Observations	64	64	64	64
Adjusted R^2	0.817	0.596	0.526	0.810
ADF t-stat (residuals)	-5.480***	-7.134***	-7.235***	-
Breusch-Godfrey LM test X^2 (prob.)	0.002	0.586	0.092	0.007

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1 (computed using heteroskedasticity- and autocorrelation-consistent standard errors with Newey-West lag window of size 3)
(1) ECM specification; (2) regressed variable: PB

Long-term FRF debt coefficient	IE	PT	ES (1)	ES (2)
Whole period	0.077	-	-	0.042
Since the crisis	0.077	0.093	0.241	0.104
Wald test (Chi-square, p-value)				
a + b	-	-	-	0

(1) Long-term FRF debt coefficients are derived as minus (-) the ratio between the estimated coefficient on lagged debt (-1) and the estimated error-correction term.

Source: Commission services.

4.2. PANEL FISCAL REACTION FUNCTION FOR CENTRAL AND EASTERN EUROPEAN COUNTRIES

As anticipated in Section 3.2, estimates for specification (4) are reported in Table 4 relying on various estimation techniques, so as to allow for checking the robustness of results to different estimation methods (particularly important given the small sample size). As already said, our preferred option is (one-step) Arellano Bond (AB) GMM (instrumenting for the lagged dependent variable and the lagged debt ratio and restricting the number of instruments to lags 2 and 3 of the instrumented variables). The simple pooled OLS model and the fixed effects (FE) model are reported as benchmarks. ([38]) The model estimated with the IV fixed effect (IV FE) estimator, with the lagged dependent variable instrumented through its first lag, is also reported for comparative purposes. The use of a FE estimator in a dynamic panel setting like ours with a small or relatively small sample is nonetheless subject to criticism in the literature (as the so called "Nickell's bias" goes to zero only when T is large , which is not the case in our sample, where the longest time series start in 1995). Judson and Owen (1999) show that the bias from using a FE estimator for dynamic panel data models can be sizeable even when $T = 20$ (the most favourable case in our unbalanced panel). Following Judson and Owen (1999) and Bruno (2005), the corrected Least Squares Dummy Variable (LSDVC) estimator and the (restricted) GMM estimator are therefore

([38]) The OLS and the FE (Within Groups) estimators are expected to be both biased in dynamic panel data models like ours, but in opposite directions (OLS upwards and FE downwards).

preferred to the FE estimator in a context like ours. We finally report results also for the AB GMM estimator, "collapsing" the instruments used for the lagged primary balance (AB GMM collapsed) to check the robustness of results to a reduction in the number of instruments. Comparing results across different estimators, we can see that the estimated coefficient on the lagged dependent variable in our preferred option (AB GMM) is not significantly lower than the FE estimate; ([39]) estimates do not change much when collapsing instruments under the AB GMM collapsed model, and are moreover generally supported by results obtained using the alternative LSDVC estimator. The estimates based on the AB GMM model are therefore selected for use in our FRF debt projection scenario. ([40])

Results show that the primary balance reacts positively to increasing public debt among CEECs (0.06 in our preferred AB GMM model, as can be seen from Table 4 below). There is strong evidence of persistence in the primary balance over time, with a greater balance in *t* leading, *ceteris paribus*, to a higher balance in the following year. Other things being equal, the primary balance responds negatively to an increase in the deviation between current and trend public expenditure, and positively to the average inflation rate of the previous three years.

A cross-country robustness check has been run on our preferred AB GMM model, by rerunning the regression eliminating one country at the time from the sample to see how estimates would change. As shown in Annex 3, our estimates appear robust to this type of test. ([41])

Table 4: **Single FRF – estimation results (dependent variable: PB, period mid-1990s-2013)**

VARIABLES	OLS	FE	IV FE	LSDVC	AB GMM	AB GMM collapsed
Lagged primary balance	**0.467*** **	**0.330*** **	**0.592*** **	**0.357*** **	**0.310*** **	**0.321*** **
	(0.0965)	(0.0385)	(0.112)	(0.0373)	(0.0543)	(0.0632)
Lagged debt	**0.0271*** **	**0.0552*** **	**0.0589*** **	**0.0544*** **	**0.0643*** **	**0.0663*** **
	(0.00583)	(0.0117)	(0.00627)	(0.00808)	(0.00917)	(0.00953)
Expenditure gap	**-0.716*** **	**-0.759*** **	**-0.696*** **	**-0.755*** **	**-0.730*** **	**-0.765*** **
	(0.102)	(0.0767)	(0.0776)	(0.0476)	(0.0658)	(0.0796)
Inflation	**0.0448*** **	**0.0656*** **	**0.0323** **	**0.0628*** **	**0.0793*** **	**0.0679*** **
	(0.0105)	(0.0109)	(0.0128)	(0.0160)	(0.0289)	(0.0163)
Constant	**-2.071*** **	**-3.488*** **	**-3.077*** **	**-**	**-3.958*** **	**-**
	(0.394)	(0.447)	(0.333)		(0.537)	
Observations	193	193	184	193	193	181
R-squared	0.690	0.727	-	-	-	-
Number of id	-	12	12	12	12	12

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Commission services.

([39]) One might want to choose an estimator lying between OLS and FE, in terms of result for the coefficient on the lagged dependent variable (the primary balance), or at least producing a result that is not significantly higher than the OLS estimate, or not significantly lower than the FE estimate (given that OLS and FE are likely to be upward and downward biased respectively). See Bond (2002).

([40]) We nonetheless acknowledge that, given the small sample size, no estimator choice appears as a first best. One problematic aspect with our choice of AB GMM lies, for instance, in the fact that GMM should typically be applied to small *T*, large *N* panels. In our case, we have small *T* (20 years at best) but also small *N*, in which case the robust standard errors and the Arellano-Bond autocorrelation test (which is safely passed by our preferred model) may become unreliable (see Roodman, 2006).

([41]) Additionally, the performance of the estimated equation in mirroring the historical behaviour of the primary balance for the countries in the sample has been assessed through the comparison between actual values of the primary balance and dynamic forecasts conducted over the past. Results are reported in Annex 3. For a panel of countries, results look satisfactory, with the only exception of HR, which could be expected as this is one of the two countries in the sample with the smallest number of observations each (EE being the country with the smallest number of observations of all, and for which the panel FRF is not used in debt projections exactly because of the very small number of observations, which make the panel FRF not representative of the country's fiscal reaction).

5. INTEGRATING FISCAL REACTION FUNCTIONS IN DEBT SUSTAINABILITY ANALYSIS

FRFs can be used in various ways. Three possible ways are explored in this section: i) deterministic public debt projections (and fiscal risk assessment); ii) calculation of debt sustainability thresholds; and iii) assessment of the degree of realism of fiscal assumptions. ([42])

5.1. USING FISCAL REACTION FUNCTIONS IN DETERMINISTIC PUBLIC DEBT PROJECTIONS AND MEDIUM-TERM FISCAL SUSTAINABILITY RISK ASSESSMENT

The FRFs estimated in this paper are used to design an alternative public debt projection scenario to the standard no-fiscal policy change scenario (which is the baseline in the Commission services' debt sustainability analysis, DSA). ([43]) In this new scenario fiscal policy (in the form of the government primary balance) is assumed to react to the debt ratio in the previous period and to macroeconomic conditions. This is obtained by integrating the traditional debt evolution equation used in the DSA with the estimated FRFs (the country-specific FRF (3), or the panel FRF (4), depending on the country under examination). For the 13 EU countries, for which it was possible to estimate country-specific FRFs, the estimates used are those displayed in Tables 2 and 3 (the second specification is used in the case of Spain). For the CEECs, for which the panel FRF was estimated, estimates used in the debt projection scenario are those obtained with the AB GMM estimator, as from Table 4.

In debt projections based on country-specific FRFs, the crisis dummy has been kept, implying that the change observed in fiscal behaviour since the 2009 financial crisis is considered as a long-term structural change. ([44]) In some cases, this could be a strong assumption (e.g. for Spain, with a strongly increased debt coefficient, and, on the other hand, for the Netherlands with an estimated coefficient showing signs of fiscal fatigue). For the CEECs, for which the panel FRF is used, imposing a fiscal behaviour captured through a single common FRF may be a strong assumption for some countries (this is the case in particular for Estonia, for which a very limited number of observations is available; which led to the decision not to present the FRF scenario in the Commission's Fiscal Sustainability Report 2015) ([45]). Finally, debt projections using the estimated FRFs are reported here (as it is the case in the Fiscal Sustainability Report 2015) based on Commission Autumn 2015 forecasts (see European Commission, 2016).

Taking into account the reaction in the government primary balance to changes in public debt (and macroeconomic variables), based on estimated historical behaviour, would lead to a higher public debt ratio (by around 3 / 4 pps. of GDP) ***at the EU / EA aggregate level in 2026 compared to the baseline no-fiscal policy change scenario*** (see Table 5). The projected primary balance under the FRF scenario, based on historical fiscal behaviour, would indeed be lower (at 0% / 0.3% of GDP on average over the period 2018-26) than under the baseline no-fiscal policy change scenario (where the government structural primary balance is simply kept constant beyond the two years of forecasts at last Commission forecast year, 2017 at the time of writing this paper). At the same time, the public debt-to-GDP ratio for the EU / EA in 2026 under the FRF scenario would be lower (by -2.3 / -0.3 pps. of GDP) than under the (more simplistic) historical structural primary balance (SPB) scenario (where the SPB is simply assumed to gradually – in 4 years – linearly converge to the last 15-year average).

([42]) Another more normative exercise would be to use the country-specific FRF debt coefficients estimated in this paper to fine-tune the primary balance norms and fiscal rules proposed in Carnot (2014).

([43]) The Commission's baseline no-fiscal policy change scenario relies on Commission forecasts for the two forecast years and on the assumption of a constant structural primary balance thereafter till the end of the 10-year projection horizon. See European Commission (2014).

([44]) It can be argued that the euro area sovereign debt crisis and the new adopted fiscal surveillance framework have permanently impacted fiscal behaviour.

([45]) Beyond Estonia, the only other country for which no FRF debt projection scenario is presented in the Commission's Fiscal Sustainability Report 2015 is Luxembourg, due to the lack of sufficiently long time series needed to estimate a country-specific FRF, and the impossibility to include the country in the estimation of the panel FRF, which was conducted on CEECs only.

Table 5: **Public debt projections under different scenarios**

	Debt 2017	Baseline no-policy change scenario		SPB historical scenario		Fiscal reaction function scenario			
		PB (average 2018-26)	Debt 2026	PB (average 2018-26)	Debt 2026	PB (average 2018-26)	Debt 2026	*Debt (difference with Baseline no-policy change scenario)*	*Debt (difference with SPB historical scenario)*
BE	106.1	0.4	98.9	1.6	89.0	0.6	96.8	-2.1	7.8
BG	33.6	-0.8	42.0	0.9	27.1	-1.7	50.2	8.2	23.1
CZ	40.5	-0.8	46.9	-2.5	61.6	-1.3	51.1	4.2	-10.5
DK	38.3	1.2	27.4	3.2	10.0	0.3	35.1	7.8	25.1
DE	65.6	1.4	50.6	0.7	56.9	1.7	48.3	-2.3	-8.6
EE	9.2	-0.4	12.0	-0.7	15.3	:	:	:	:
IE	93.7	0.1	85.0	-2.0	102.7	-2.6	108.4	23.4	5.7
EL	:	:	:	:	:	:	:	:	:
ES	100.4	0.9	91.8	0.3	96.8	-1.8	113.8	21.9	17.0
FR	97.4	-0.8	101.0	-1.8	108.7	-1.7	108.8	7.8	0.1
HR	92.9	0.1	105.3	-1.6	119.8	2.7	83.0	-22.3	-36.8
IT	130.0	2.7	110.1	2.2	114.3	2.7	109.6	-0.5	-4.7
CY	:	:	:	:	:	:	:	:	:
LV	37.6	-0.3	33.4	-1.0	38.5	-1.7	44.6	11.2	6.1
LT	42.5	-0.3	50.1	-1.9	65.0	-0.9	57.4	7.3	-7.6
LU	23.5	0.6	13.6	1.0	9.8	:	:	:	:
HU	72.6	1.6	60.1	0.0	73.5	0.9	65.5	5.4	-8.0
MT	61.0	0.3	54.9	-0.8	64.6	0.0	57.3	2.4	-7.3
NL	66.9	0.1	62.7	0.9	56.0	-1.3	74.5	11.8	18.6
AT	84.3	0.9	72.5	0.7	73.6	-0.3	82.6	10.1	9.0
PL	53.5	-1.5	62.5	-1.9	65.9	-0.6	54.8	-7.7	-11.1
PT	121.3	1.9	111.8	-0.6	131.6	1.3	116.1	4.3	-15.5
RO	42.8	-2.5	61.1	-2.1	57.5	-1.2	50.6	-10.6	-6.9
SI	78.3	-0.4	81.2	-1.3	88.4	1.3	66.9	-14.3	-21.4
SK	52.2	-0.5	51.5	-1.9	63.1	-0.7	52.7	1.2	-10.4
FI	65.7	-1.3	75.5	1.2	53.9	1.2	53.4	-22.1	-0.4
SE	43.3	-0.5	42.7	1.4	26.4	1.0	29.8	-12.9	3.4
UK	86.9	-0.6	89.8	-2.5	104.9	-1.1	93.9	4.1	-11.0
EU	85.5	0.4	79.5	-0.2	85.0	0.0	82.7	3.2	-2.3
EA	91.3	0.9	81.9	0.3	86.6	0.3	86.3	4.4	-0.3

(1) Underlying assumptions are based on Commission Autumn 2015 forecasts. SPB: structural primary balance.

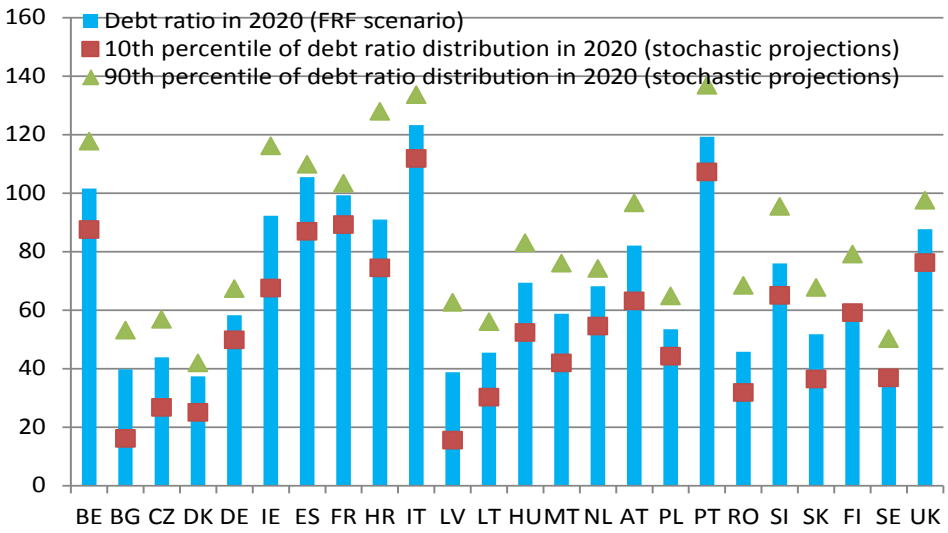
Source Commission services.

Looking at country-specific results in Table 5, the debt ratio would be lower in 2026 under the FRF scenario compared to both the baseline and the historical SPB scenarios for 7 countries (HR, FI, SI, RO, PL, DE and IT). A relatively high or increased FRF debt coefficient since the 2009 financial crisis can explain in some cases this result (e.g. for Finland, Germany and Italy). In other cases, fiscal assumptions, under both the baseline and the historical SPB scenario, seem, to some extent, over-pessimistic relative to European fiscal standards (e.g. for Croatia, Slovenia, Romania and Poland). ([46]) The public debt ratio would lie by 2026 above the baseline scenario and below or close to the historical SPB scenario for other 8 countries (SK, MT, UK, CZ, PT, HU, LT and FR). This result seems to be driven by relatively pessimistic fiscal assumptions in the historical SPB scenario (e.g. for Slovakia, Czech Republic, Hungary and Lithuania) and, in some cases, by a relatively high or an increase in fiscal responsiveness since the 2009 financial crisis (e.g. for Portugal, the UK and France). Integrating the FRF in debt projections increases the public debt-to-GDP ratio at the end of the projections, compared to both the baseline and the historical SPB scenarios, for 7 countries (e.g. DK, BG, AT, LV, NL, ES and IE), pointing in these cases to (slightly) over-optimistic fiscal assumptions in the baseline and/or the historical SPB scenarios (e.g. for Denmark and Ireland), to a weak FRF debt coefficient or to some fiscal fatigue (e.g. for Austria and the Netherlands).

([46]) The degree of optimism / pessimism of fiscal assumptions is appreciated by percentile ranks' values calculated over the distribution of all EU countries' SPBs over the period 1980-2015 (see European Commission, 2016).

By comparing these results with stochastic debt projection results, ([47]) we can see that, for all countries considered, the projected debt ratio obtained in 2020 under the FRF scenario lies above (sometimes well above) the lower limit of the stochastic projection cone (the 10th percentile of the debt ratio distribution obtained by simulating joint random shocks to the underlying macroeconomic variables, including the government primary balance; see Graph 4). The gap is, however, relatively small for Finland and Sweden, meaning that when taking into account historical fiscal behaviour, debt projections appear relatively favourable. In all cases, the projected debt ratio obtained in 2020 under the FRF scenario lies below the upper limit of the stochastic projection cone (the 90th percentile of the debt ratio distribution). Nevertheless, the relatively small gaps obtained for some countries (such as France or the Netherlands) point to unfavourable projections under the FRF scenario.

Graph 4: **Debt ratio in 2020 in FRF scenario, compared to lower / upper debt distribution percentiles of stochastic projection cone (% of GDP)**



Source: Commission services.

As can be seen from Table 6, the results obtained for the FRF scenario in most cases confirm the medium-term sustainability risk assessment by the Commission services based on the DSA, obtained by focussing on more traditional debt projection scenarios, like the baseline no-fiscal policy change scenario and the historical SPB scenario, plus a set of sensitivity tests on macro-fiscal assumptions, including stochastic projections (see European Commission, 2016, and in particular Annex A11, for all the details on the risk assessment criteria and critical thresholds used, which have been additionally applied to the FRF scenario in Table 6 here below). However, for some countries (HR, PL, RO, SI and FI), the FRF scenario would point to lower risks as compared to the overall DSA-based medium-term risk assessment in European Commission (2016). This result appears to be in line with the relatively high fiscal responsiveness found for these countries (especially in the case of Finland).

([47]) Based on the historical variance-covariance matrix approach, as from the Commission's Fiscal Sustainability Report 2015. See Berti (2013) for more details.

Table 6: **Summary heat map on fiscal sustainability challenges: section on debt sustainability analysis with addition of FRF scenario**

	Heat map for medium-term risks in the EU countries											
	Sovereign-debt sustainability risks in the EU countries											
	BE	BG	CZ	DK	DE	IE	ES	FR	HR	IT	LV	LT
Baseline no-policy change scenario	HIGH	LOW	LOW	LOW	LOW	MEDIUM	HIGH	HIGH	HIGH	HIGH	LOW	LOW
Debt level (2026)	98.9	42.0	46.9	27.4	50.6	85.0	91.8	101.0	105.3	110.1	33.4	50.1
Debt peak year	2016	2026	2026	2015	2015	2015	2016	2026	2026	2015	2016	2026
Average Structural Primary Balance (2017-2026) Percentile rank	46%	73%	61%	52%	26%	33%	53%	65%	58%	20%	66%	45%
Historical SPB scenario	MEDIUM	LOW	MEDIUM	LOW	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	MEDIUM
Debt level (2026)	89.0	27.1	61.6	10.0	56.9	102.7	96.8	108.7	119.8	114.3	38.5	65.0
Debt peak year	2016	2019	2026	2015	2015	2026	2016	2026	2026	2015	2016	2026
Average Structural Primary Balance (2017-2026) Percentile rank	29%	53%	78%	25%	34%	65%	62%	74%	76%	24%	72%	68%
Debt sustainability analysis - overall risk assessment	HIGH	LOW	LOW	LOW	LOW	HIGH	HIGH	HIGH	HIGH	HIGH	LOW	LOW
Fiscal reaction function scenario	HIGH	LOW	LOW	LOW	LOW	HIGH	HIGH	HIGH	MEDIUM	HIGH	LOW	LOW
Debt level (2026)	96.8	50.2	51.1	35.1	48.3	108.4	113.8	108.8	83.0	109.6	44.6	57.4
Debt peak year	2016	2026	2026	2015	2015	2026	2026	2026	2018	2015	2026	2026
Average Structural Primary Balance (2017-2026) Percentile rank	42%	81%	66%	65%	24%	72%	81%	73%	24%	20%	79%	56%

	Heat map for medium-term risks in the EU countries											
	Sovereign-debt sustainability risks in the EU countries											
	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK
Baseline no-policy change scenario	MEDIUM	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	LOW	MEDIUM	LOW	MEDIUM
Debt level (2026)	60.1	54.9	62.7	72.5	62.5	111.8	61.1	81.2	51.5	75.5	42.7	89.8
Debt peak year	2015	2015	2015	2015	2026	2015	2026	2015	2015	2026	2015	2026
Average Structural Primary Balance (2017-2026) Percentile rank	40%	41%	63%	37%	73%	26%	82%	60%	63%	63%	62%	57%
Historical SPB scenario	MEDIUM	MEDIUM	LOW	MEDIUM	MEDIUM	HIGH	LOW	MEDIUM	MEDIUM	MEDIUM	LOW	HIGH
Debt level (2026)	73.5	64.6	56.0	73.6	65.9	131.6	57.5	88.4	63.1	53.9	26.4	104.9
Debt peak year	2015	2015	2015	2015	2026	2026	2026	2026	2026	2018	2015	2026
Average Structural Primary Balance (2017-2026) Percentile rank	65%	60%	49%	39%	76%	61%	79%	71%	76%	26%	32%	77%
Debt sustainability analysis - overall risk assessment	MEDIUM	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	HIGH	HIGH	LOW	HIGH	LOW	HIGH
Fiscal reaction function scenario	MEDIUM	LOW	MEDIUM	MEDIUM	LOW	HIGH	LOW	MEDIUM	LOW	LOW	LOW	HIGH
Debt level (2026)	65.5	57.3	74.5	82.6	54.8	116.1	50.6	66.9	52.7	53.4	29.8	93.9
Debt peak year	2015	2015	2026	2015	2026	2015	2026	2015	2026	2017	2015	2026
Average Structural Primary Balance (2017-2026) Percentile rank	51%	45%	76%	56%	64%	32%	72%	33%	65%	26%	37%	64%

(1) SPB: structural primary balance.

Source: Commission services.

5.2. DERIVING PUBLIC DEBT SUSTAINABILITY THRESHOLDS FOR SELECTED EU COUNTRIES

FRFs can be used to derive *public debt sustainability thresholds*, i.e. public debt levels beyond which governments don't meet anymore the inter-temporal budgetary condition ([48]) (see European Commission, 2011). When considering in addition financial markets' reaction to rising public debt, these functions also enable computing public debt limits, i.e. public debt levels beyond which governments are theoretically at risk of losing financial market access (see Gosh *et al*, 2011; Fournier and Fall, 2015). Finally, going a step further, some recent papers use FRF estimates to measure fiscal space (as the difference between the public debt limit and actual public debt; see Ostry *et al*, 2015).

It is, however, worthy noting that conclusions reached by applying the aforementioned approaches necessarily have some important caveats attached, as they carry with them the potential weaknesses of the econometric estimations and the high sensitivity of the results to the assumptions on the interest rate–growth rate differential. Furthermore, these backward-looking approaches do not integrate potential future liabilities, linked, for example, to ageing societies or the banking sector. Based on a single metric, debt thresholds' estimates do not account for other relevant factors, like the structure of public debt financing (in terms of maturity, currency or creditors). Finally, theoretical measures of debt limits can prove much higher than the level at which sovereigns can actually face financial stress. While keeping these caveats in mind, tentative estimations of *public debt sustainability thresholds* are made based on the country-specific FRFs estimated in this paper (thus for around half of EU Member States).

As in European Commission (2011), the public debt sustainability threshold for country i (DT_i) is derived by integrating the average estimated primary balance (from the FRF) with the traditional solvency condition (as in (2)), and solving the equation for the debt-to-GDP ratio:

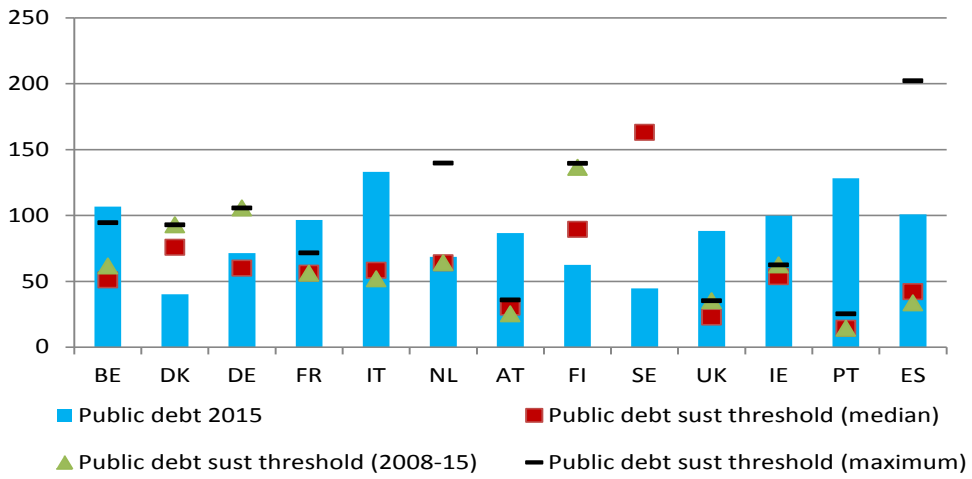
$$DT_i = \frac{\widehat{PB}_i}{reff_i - g_i} \qquad (5)$$

([48]) In steady-state, a given stock of government debt can be considered sustainable according to this condition if it does not exceed the steady-state primary surplus relative to the steady-state interest-rate-GDP growth rate differential (see equation (2)).

where $\widehat{PB}_i$ is the average estimated primary balance (as a share of GDP) for country i, based on the country-specific FRF over the period covered by the model; $reff_i$ is the average real implicit interest rate and g_i is the average real GDP growth rate for country i. The interest-rate–growth rate differential used in the calculations reflects historical values. Given the sensitivity of the results to different interest rate-growth rate assumptions, several historical periods have been considered (1950–2013; 1975–2013; 1990–2013; 2008–2013 and 2008–2015). Moreover, as in European Commission (2011), to avoid excluding some countries, for negative values of the average estimated primary balance, an average calculated solely on positive values is used, implying in this case an over-estimation of public debt thresholds. The same methodology has been used for the average interest rate–growth rate differential, in which case public debt thresholds are instead under-estimated. ([49])

Based on these estimations, 7 countries (BE, FR, IT, AT, UK, IE and PT) would have a public debt ratio close or above its sustainability threshold, whatever the measure of the debt sustainability threshold considered (median, maximum or calculated under recent macro-financial conditions). ([50]) On the contrary, for Denmark and Finland, the current public debt ratio would never exceed the threshold, however measured, while for Germany it would only exceed it when considering the median value of the debt sustainability threshold. However, as pointed out before, this type of analysis has clear limitations. For example, in the case of Finland, when additionally taking into account future projected public spending related to the ageing population, fiscal risks appear to be substantial in the long term (at medium risk according to the Commission services' assessment criteria).

Graph 5: **Public debt sustainability thresholds (% of GDP) based on fiscal reaction functions, selected EU countries**



Source: Commission services.

5.3. ASSESSING THE DEGREE OF REALISM OF FISCAL ASSUMPTIONS

One of the underlying assumptions having a key role in driving debt projection results and fiscal risk assessments is the one made on the (structural) primary balance. Hence, in their DSAs, both the IMF and the European Commission provide a measure of the degree of realism of the underlying fiscal assumptions made in the main debt projection scenarios. In the Commission services' DSA framework, this is done by looking at the percentile rank of the average projected structural primary balance calculated based on the SPB distribution for all EU countries. ([51])

([49]) Indeed, the calculation of debt thresholds only makes economic sense when both the average primary balance and the average interest rate-growth rate differential are positive. In cases where real GDP growth exceeds systematically the real implicit interest rate, any debt-to-GDP ratio can be theoretically sustained. On the other hand, a negative steady-state primary balance would imply a negative debt threshold, which is also a trivial outcome for our purposes (see European Commission, 2011).

([50]) The median public debt sustainability threshold is calculated over the different values obtained depending on the time horizon considered for the interest rate-growth rate differential. The maximum public debt sustainability threshold is the highest level obtained over the different time horizons. Finally, the public debt sustainability threshold for 2008-15 corresponds to the value obtained under the macro-financial conditions over the reference period.

([51]) The percentile rank is calculated over the distribution of all EU countries' SPBs, considered over the long term (1980-2015). See European Commission (2014) for more details.

Two of the main scenarios included in the Commission services' DSA are of particular interest from the point of view of the assessment of the degree of realism of underlying fiscal assumptions, given the role they play in the assessment of sustainability challenges. These are: i) the baseline no-fiscal policy change scenario (already considered and defined in previous sections), and ii) the Stability and Growth Pact (SGP) scenario (which assumes respect of Council recommendations under the Excessive Deficit Procedure, as well as respect of the convergence of the government structural balance to the medium-term objective, as from the preventive arm of the Pact). ([52]) According to the percentile rank criterion, the SPB assumed in the baseline scenario is found to be relatively high by European historical standards for 3 countries (Germany, Italy and Portugal; see Table 7). In the SGP scenario, it would be relatively high for 11 EU countries (with particularly high values recorded for Italy and Portugal).

One important drawback of the aforementioned SPB percentile rank criterion (especially if looked at in isolation) is that it relies on the SPB distribution of *all* EU countries. Yet, some countries have proven in the past to be able to sustain large primary surpluses over a long period of time (e.g. Denmark, Finland, Belgium and Sweden). ([53]) Accordingly, we have seen that some countries exhibit much higher fiscal responsiveness than others. Therefore, as proposed by Checherita-Westphal and Žďarek (2015), FRF results could be additionally used to define country-specific primary balance benchmarks. The latter could be used to assess the degree of realism of fiscal projections in the two scenarios (baseline and SGP). More precisely, for each country *i*, the primary balance benchmark (PB_i^B) is defined as follows:

$$PB_i^B = \overline{PB}_i^{MS} + \gamma_i . \Delta D \qquad (6)$$

where $\overline{PB}_i^{MS}$ is a maximum primary balance sustained by country *i* in the past; γ_i is the long-term FRF debt coefficient and ΔD is the variation of the public debt ratio (set at +10 pps. of GDP). ([54]) Two alternative measures of the maximum primary balance sustained are considered: i) based on the maximum average of positive primary balances sustained over 5 consecutive years (since 1975) (benchmark 1); and ii) based on the average of positive primary balances (since 1975) (benchmark 2). Risks of fiscal fatigue (or the degree of realism of the fiscal assumptions) are considered low if the average projected primary balance is below $\overline{PB}_i^{MS}$ (meaning that the underlying assumptions are not overly optimistic). Risks are considered medium when the projected PB is above $\overline{PB}_i^{MS}$ but below PB_i^B; finally, risks are flagged as high if the projected PB is above PB_i^B (meaning that the fiscal assumptions will be considered ambitious compared to the country's historical track-record).

Results displayed in Table 7 below show that, in the Commission services' baseline scenario, fiscal assumptions would be considered as relatively optimistic based on country-specific historical track-record for 2 countries (Croatia and Portugal). For Italy, the assessment differs depending on whether the first (the highest) or the second benchmark is used. On the other hand, risks of fiscal fatigue would be considered low in Germany (which is, on the contrary, highlighted in yellow under the percentile rank dimension currently in use).

In the SGP scenario, results differ substantially depending on the benchmark used (with 7 countries at medium/high risk in one case and 12 in the other). The countries for which the diagnosis would always differ compared to the percentile rank criterion are Belgium and Ireland (which would not flag anymore), and Czech Republic, Lithuania and Slovakia (which would now be identified as being at risk of fiscal fatigue).

([52]) See European Commission (2016) for more details.

([53]) To be able to assess this additional dimension, in the charts included in the Commission's DSA, the percentile rank of the projected SPB for the specific debt projection scenario, calculated out of the distribution of all EU countries' SPBs, is accompanied by the indication of the percentile rank of the country-specific SPB historical average (over the past 15 years), always based on the distribution of all EU countries' SPBs. See European Commission (2014 and 2016).

([54]) This means that we allow for an increased benchmark, compared to the maximum PB observed in the past, calibrated as a 10 pp. of GDP rise in the public debt ratio compensated by a corresponding tightening in the fiscal balance.

Table 7: **Assessing the degree of realism of fiscal projections using fiscal reaction functions**

	Heat map for medium-term risks in the EU countries											
	Sovereign-debt sustainability risks in the EU countries											
	BE	BG	CZ	DK	DE	IE	ES	FR	HR	IT	LV	LT
Baseline no-policy change scenario	HIGH	LOW	LOW	LOW	LOW	MEDIUM	HIGH	HIGH	HIGH	HIGH	LOW	LOW
Average Structural Primary Balance (2017-2026) Percentile rank	46%	73%	61%	52%	26%	33%	53%	65%	58%	20%	66%	45%
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 1)	0.4	-0.9	-0.7	1.0	1.4	0.3	0.8	-0.9	0.1	2.7	-0.3	-0.2
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 2)	0.4	-0.9	-0.7	1.0	1.4	0.3	0.8	-0.9	0.1	2.7	-0.3	-0.2
Stability and Growth Pact (SGP) scenario	MEDIUM	LOW	LOW	LOW	LOW	MEDIUM	MEDIUM	MEDIUM	MEDIUM	HIGH	LOW	LOW
Average Structural Primary Balance (2017-2026) Percentile rank	18%	55%	52%	43%	24%	20%	19%	27%	23%	11%	59%	42%
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 1)	2.9	0.0	0.3	0.5	2.1	2.5	2.6	1.7	2.2	3.8	0.0	0.8
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 2)	2.9	0.0	0.3	0.5	2.1	2.5	2.6	1.7	2.2	3.8	0.0	0.8

	Heat map for medium-term risks in the EU countries											
	Sovereign-debt sustainability risks in the EU countries											
	HU	MT	NL	AT	PL	PT	RO	SI	SK	FI	SE	UK
Baseline no-policy change scenario	MEDIUM	LOW	MEDIUM	MEDIUM	MEDIUM	HIGH	MEDIUM	MEDIUM	LOW	MEDIUM	LOW	MEDIUM
Average Structural Primary Balance (2017-2026) Percentile rank	40%	41%	63%	37%	73%	26%	82%	60%	63%	63%	62%	57%
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 1)	1.6	0.4	0.1	0.9	-1.5	1.9	-2.5	-0.3	-0.5	-1.3	-0.5	-0.5
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 2)	1.6	0.4	0.1	0.9	-1.5	1.9	-2.5	-0.3	-0.5	-1.3	-0.5	-0.5
Stability and Growth Pact (SGP) scenario	MEDIUM	LOW	LOW	MEDIUM	LOW	HIGH	LOW	LOW	LOW	LOW	LOW	MEDIUM
Average Structural Primary Balance (2017-2026) Percentile rank	35%	27%	40%	29%	48%	13%	51%	24%	41%	39%	56%	41%
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 1)	1.3	1.9	0.9	1.6	0.4	3.5	0.3	2.3	0.8	0.7	0.0	0.9
Primary balance (2017-26) - fiscal fatigue risk (PB benchmark 2)	1.3	1.9	0.9	1.6	0.4	3.5	0.3	2.3	0.8	0.7	0.0	0.9

Source: Commission services.

6. CONCLUSIONS

Reassuringly, most EU countries are found to positively adjust their fiscal policy to rising levels of debt, although to a weak extent in some cases. The country variability of the results obtained, in line with the literature, highlights the advantages of estimating country-specific FRFs, when possible. Since the financial crisis, over the sub-sample of EU countries for which country-specific estimates have been obtained in this paper, fiscal responsiveness to public debt appears to have generally increased, in line with the change in financial markets' perceptions, as well as the renewed EU fiscal surveillance framework.

When using FRFs to project public debt levels in the medium term, results are on average less favourable than under the standard baseline no-fiscal policy change scenario used by the Commission services (which relies on the assumption of fiscal policy remaining constant as of last Commission forecast year - 2017 at the time of writing this paper), pointing to the relatively high current fiscal stance in the EU. Debt ratios would, however, on average reach lower levels in the FRF scenario compared to a historical debt projection scenario (based on a simple gradual convergence of the government balance to the last 15-year historical average), thereby illustrating the increase of fiscal responsiveness since the sovereign debt crisis.

The analysis of risks based on a FRF debt projection scenario generally corroborates the summary medium-term sustainability risk assessment made by the European Commission services (2016) based on more traditional debt projection scenarios and sensitivity tests. For some countries though (which have proven in the past to be able to strongly adjust their fiscal policy to preserve fiscal sustainability) risks would appear as less prominent. Interestingly, following Checherita-Westphal and Ždarek (2015) methodology, the analysis based on FRFs' estimates can allow gauging the degree of realism of fiscal assumptions made in different scenarios, taking into account country specificities. The countries identified as being at risk of fiscal fatigue would somehow differ in this case compared to measures based on EU distributions. For example, the fiscal effort assumed in the Stability and Growth Pact scenario would appear as relatively ambitious, compared to national historical fiscal behaviour, in the case of Croatia, Czech Republic, Lithuania and Slovakia. On the other hand, for some other countries that have been able to sustain large primary surpluses in the past, the required fiscal adjustment to reach Stability and Growth Pact targets, even if large, would appear as reachable (e.g. for Belgium, Ireland and, to some extent, Italy).

Beyond the useful applications explored in this paper (that fed into the European Commission's Fiscal Sustainability Report 2015), other work streams using estimated FRFs could be further explored in the future. These could include public debt limits (a more elaborated concept relative to the public debt sustainability thresholds explored in this paper), as well as primary balance norms and fiscal rules (as proposed in Carnot, 2014). Yet, it remains important to keep in mind that, when it comes to evaluate fiscal sustainability risks, a holistic approach is required, and no simple metric will ever be able in itself to fully capture the ability of a sovereign to honour its debt.

ANNEX 1 – THE DATASET AND DESCRIPTIVE CHARTS

Table A1.1 below details the statistical sources used to construct the dataset. As in Mauro *et al* (2013), for fiscal variables, source-consistency across concepts has been favoured over continuity over time. The strategy followed can be summarised by the following decision tree:

- when data are available for both the primary balance and public debt in AMECO, AMECO is chosen as the statistical source (often the case from the mid-90's until 2013; as well as for primary expenditure and the implicit interest rate on public debt);
- when data are available for one series in AMECO (often public debt) and not another one (often the primary balance), but both series are available in the Historical Public Finance Database (HPFD), the latter is chosen as the statistical source.

The HPFD series are linked across time to the AMECO series by applying the growth rates of these series in HPFD to the first-year level of the AMECO series.

Table A1.1: **Statistical sources used to construct the dataset**

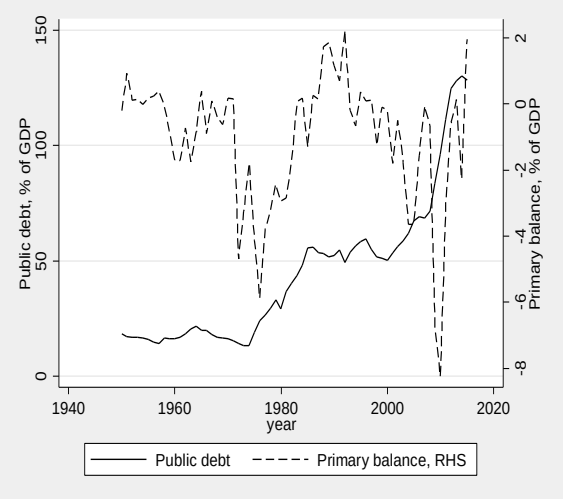
Variable	**Data source**	**Comments**
Primary balance (as a % of GDP)	AMECO ([55]) and HPFD ([56])	Data put together in a source-consistent way (i.e. at every point in time, PB and debt come from the same data source). Dummies for changes in sources have been introduced (for the HPFD).
Public debt (as a % of GDP)	AMECO and HPFD	
Expenditure gap (difference between current and trend public primary expenditures, % of GDP)	AMECO and HPFD	Like for other fiscal variables, the data sources have been chosen in a way to ensure source-consistency. Trend series estimated by applying a standard Hodrick–Prescott filter.
Output gap (%)	AMECO and Maddison project dataset ([57])	AMECO directly provides output gap series. Maddison source: output gap calculated by decomposing (real) GDP series into its cyclical component and its trend component using a standard Hodrick–Prescott filter. The linking between the two datasets has been done by using primarily AMECO data, and extending each individual series using estimates derived from Maddison data. To avoid hikes in the linked series, the linking has been done at the closest point between the series within 5 years of the AMECO series starting point.
Inflation (%)	AMECO and Reinhart and Rogoff dataset ([58])	-
Implicit interest rate on public debt (%)	AMECO and HPFD	Like for other fiscal variables, the data sources have been chosen in a way to ensure source-consistency.

([55]) See http://ec.europa.eu/economy_finance/ameco/user/serie/SelectSerie.cfm
([56]) See http://www.imf.org/external/np/fad/histdb/
([57]) See http://www.ggdc.net/maddison/maddison-project/home.htm
([58]) See http://www.carmenreinhart.com/data/browse-by-topic/topics/2/

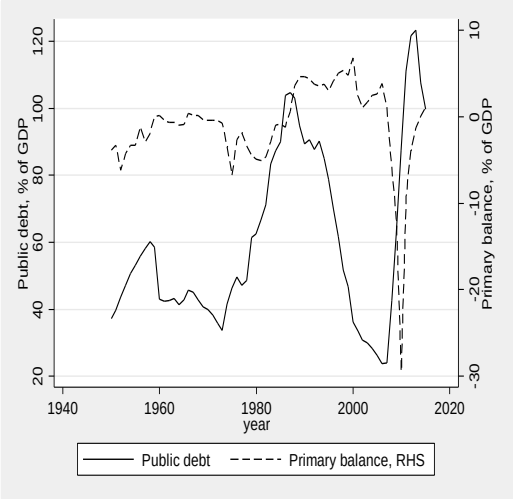
Here below we report the charts of public debt and the primary balance for the 13 EU countries for which long time series are available (and country-specific FRFs are estimated in this paper).

Graph A1.1: **Public debt and primary balance as % of GDP – EU countries object of analysis that benefited from an adjustment programme during the crisis (public debt greater than 90% of GDP in 2014)**

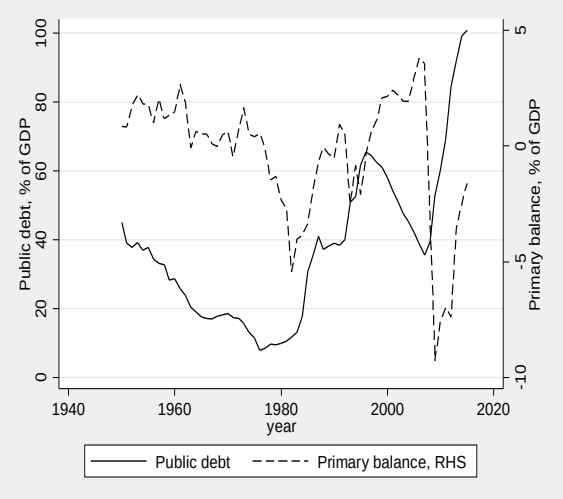
PT



IE



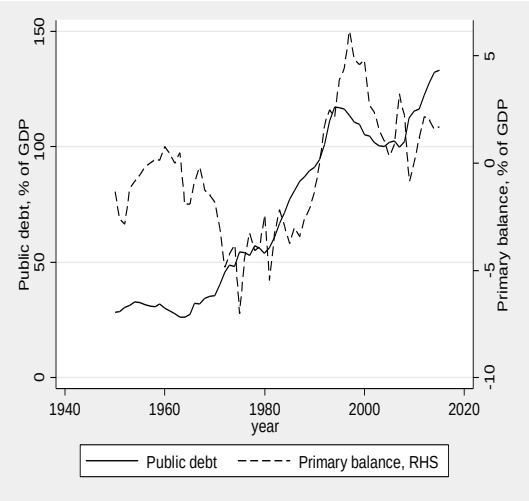
ES



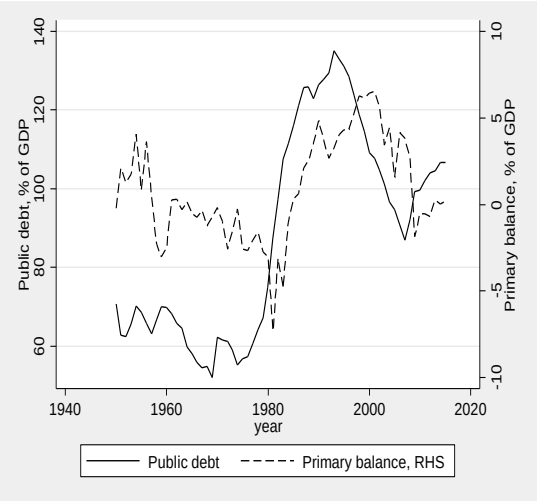
Source: Commission services.

Graph A1.2: **Public debt and primary balance as % of GDP – EU countries object of analysis with high debt level in 2014-15 (above 90% of GDP)**

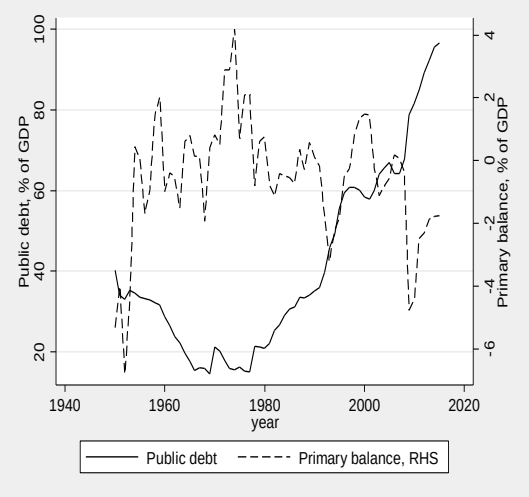
IT



BE



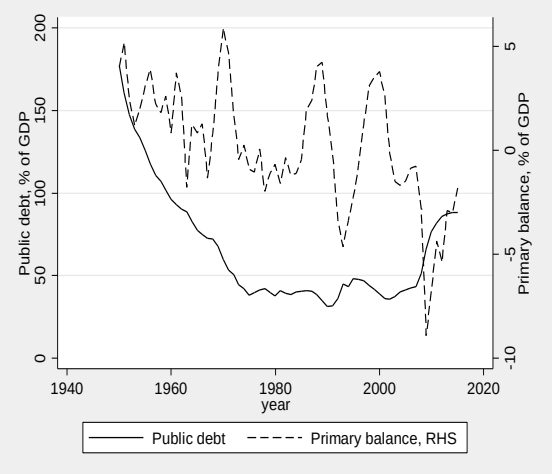
FR



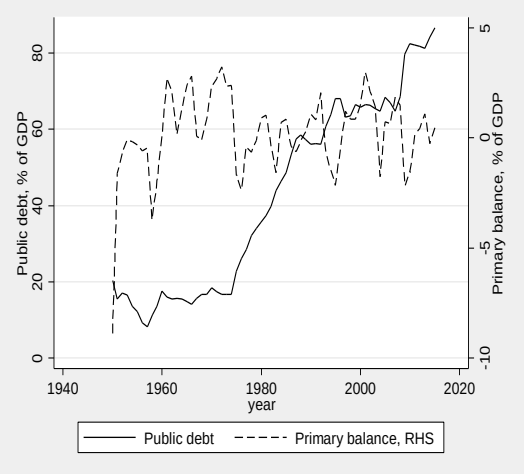
Source: Commission services.

Graph A1.3: **Public debt and primary balance as % of GDP – EU countries object of analysis with a medium to high debt level in 2014-15 (between 60% and 90% of GDP)**

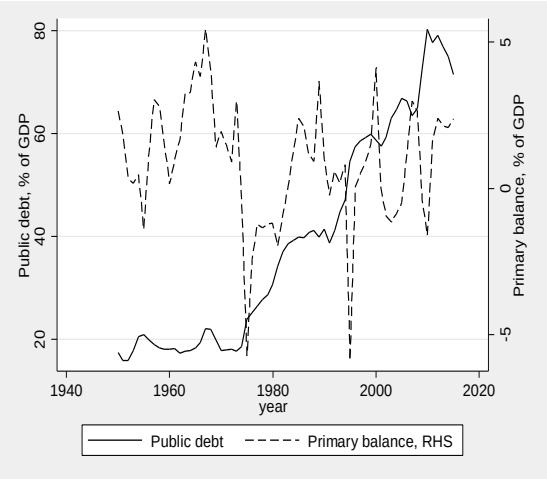
UK



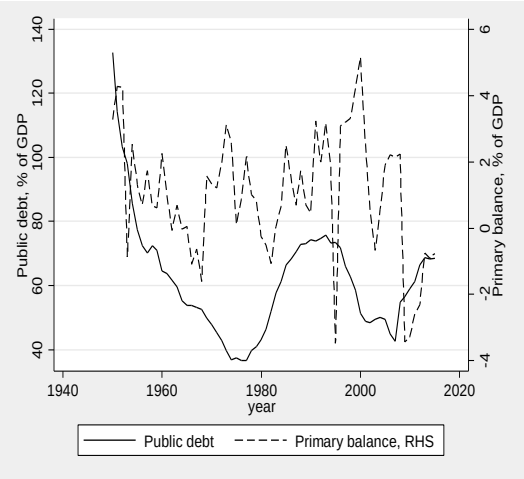
AT



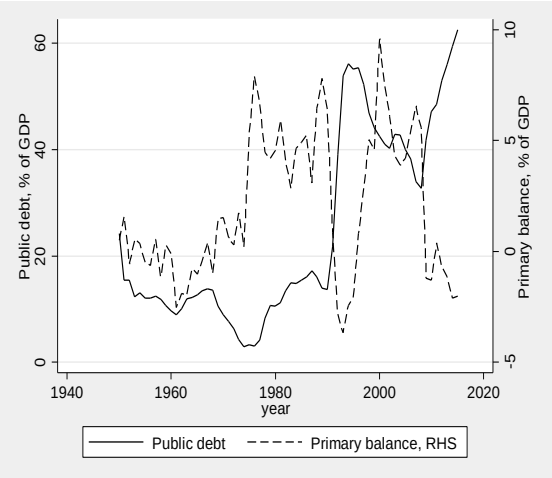
DE



NL

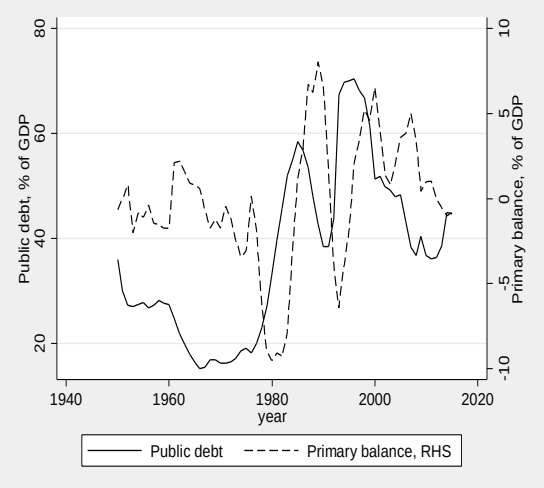
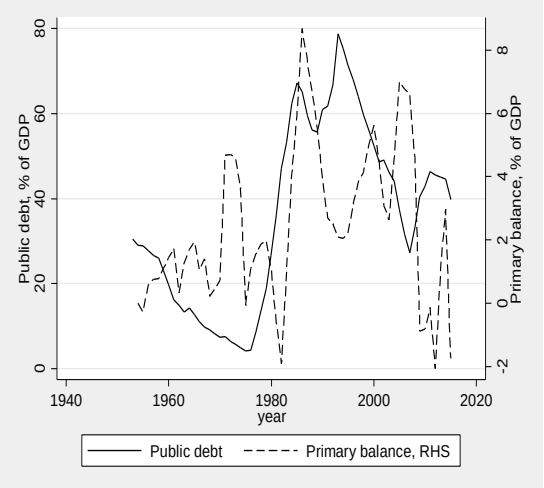


FI



Source: Commission services.

Graph A1.4: **Public debt and primary balance as % of GDP – EU countries object of analysis with a low to medium debt level (below 60% of GDP)**

SE	DK
	

Source: Commission services.

ANNEX 2 – STATIONARITY TESTS

Unit root / stationarity tests for the 13 EU countries for which long time series are available show that the public debt ratio is I(1) in the majority of cases (see Table A2.1). The primary balance is found to be more often stationary over the period 1950–2013 (see Table A2.2). However, these results are to some extent driven by end-of-period observations (since the financial crisis), where the primary balance has experienced large swings in several countries. Excluding the years 2009–13, this variable is found to be I(1) in about half of the cases (see Table A2.3). Other variables entering the FRF (expenditure gap, output gap, inflation and real implicit interest rate) are generally found to be stationary (see Table A2.4).

These results must nonetheless be considered with caution given unit root tests' weaknesses (as illustrated by Bohn, 1998, that performs his own ADF-type regressions on the debt ratio), and ultimately, the choice of the specification retained (in level or in first difference) is to some extent arbitrary. However, as pointed out by Keele and De Boef (2004), an ECM specification can be appealing also for stationary series.

Table A2.1: **Unit root / stationarity tests on the public debt ratio, period 1950-2013, intercept and automatic lag length selection (test statistics)**

	ADF test	PP test	KPSS test	Conclusion
	H0: Debt is I(1)	H0: Debt is I(1)	H0: Debt is I(0)	
BE	-4.136***	-4.077***	0.128+++	Debt is I(1) according to 3 tests
DK	-3.421**	-3.467**	0.122+++	Debt is I(1) according to 3 tests
DE	-5.565***	-5.325***	0.304+++	Debt is I(1) according to 3 tests
FR	-4.624***	-4.624***	0.323+++ (2nd difference)	Debt is I(1) according to 2 tests, I(2) according to KPSS test
IT	-4.396***	-4.390***	0.143+++	Debt is I(1) according to 3 tests
NL	-4.673*** (level)	-5.450*** (level)	0.233+++ (level)	Debt is I(0) according to 3 tests
AT	-5.848***	-4.892***	0.428++	Debt is I(1) according to 3 tests
FI	-3.315***	-3.86***	0.257+++	Debt is I(1) according to 3 tests
SE	-4.679***	-4.679***	0.112+++	Debt is I(1) according to 3 tests
UK	-3.922***	-3.858*** (level)	0.500+++ (2nd difference)	Debt is I(0), I(1) or I(2) according to test considered
IE	-3.549***	-3.549***	0.219+++ (level)	Debt is I(1) according to 2 tests, I(0) according to KPSS test
PT	-4.007***	-4.043***	0.456++	Debt is I(1) according to 3 tests
ES	-3.647***	-3.649***	0.425+++	Debt is I(1) according to 3 tests

$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$ for ADF and PP tests (H0: series has a unit root); $^{+++}p<0.01$, $^{++}p<0.05$, $^{+}p<0.1$ for KPSS test (H0: series is stationary).

Source: Commission services.

Table A2.2: **Unit root / stationarity tests on the primary balance ratio, period 1950-2013, intercept and automatic lag length selection (test statistics)**

	ADF test	PP test	KPSS test	Conclusion
	H0: PB is I(1)	H0: PB is I(1)	H0: PB is I(0)	
BE	-10.367***	-10.343***	0.329+++ (level)	PB is I(1) according to 2 tests, I(0) according to KPSS
DK	-3.780*** (level)	-5.628***	0.324+++ (level)	PB is I(0) according to 2 tests, I(1) according to PP test
DE	-4.250*** (level)	-4.289*** (level)	0.179+++ (level)	PB is I(0) according to 3 tests
FR	-4.154*** (level)	-4.106*** (level)	0.169+++ (level)	PB is I(0) according to 3 tests
IT	-8.853***	-8.997***	0.094+++	PB is I(1) according to 3 tests
NL	-4.699*** (level)	-4.648*** (level)	0.125+++ (level)	PB is I(0) according to 3 tests
AT	-6.157*** (level)	-7.620*** (level)	0.211+++ (level)	PB is I(0) according to 3 tests
FI	-7.328***	-7.515***	0.324+++ (level)	PB is I(1) according to 2 tests, I(0) according to KPSS
SE	-3.655*** (level)	-4.947***	0.249+++ (level)	PB is I(0) according to 2 tests, I(1) according to PP test
UK	-2.973** (level)	-3.106** (level)	0.040+++	PB is I(0) according to 2 tests, I(1) according to KPSS test
IE	-3.240** (level)	-3.362** (level)	0.128+++ (level)	PB is I(0) according to 3 tests
PT	-8.687***	-3.537*** (level)	0.148+++ (level)	PB is I(0) according to 2 tests, I(1) according to ADF test
ES	-3.006** (level)	-6.351***	0.280+++ (level)	PB is I(0) according to 2 tests, I(1) according to PP test

***p<0.01, **p<0.05, *p<0.1 for ADF and PP tests (H0: series has a unit root); $^{+++}$p<0.01, $^{++}$p<0.05, $^{+}$p<0.1 for KPSS test (H0: series is stationary).
Source: Commission services.

Table A2.3: **Unit root / stationarity tests on the primary balance ratio, period 1950-2008, intercept and automatic lag length selection (test statistics)**

	ADF test	PP test	KPSS test	Conclusion
	H0: PB is I(1)	H0: PB is I(1)	H0: PB is I(0)	
BE	-10.334***	-10.303***	0.433++ (level)	PB is I(1) according to 2 tests, I(0) according to KPSS
DK	-3.507** (level)	-4.689***	0.0448+++	PB is I(1) according to 2 tests, I(0) according to ADF
DE	-3.936*** (level)	-3.943*** (level)	0.192+++ (level)	PB is I(0) according to 3 tests
FR	-4.292*** (level)	-4.269*** (level)	0.193+++ (level)	PB is I(0) according to 3 tests
IT	-8.827***	-8.777***	0.347++ (level)	PB is I(1) according to 2 tests, I(0) according to KPSS test
NL	-5.241*** (level)	-5.189*** (level)	0.195+++ (level)	PB is I(0) according to 3 tests
AT	-5.885*** (level)	-6.853*** (level)	0.285+++ (level)	PB is I(0) according to 3 tests
FI	-7.101***	-7.296***	0.051+++	PB is I(1) according to 3 tests
SE	-3.481*** (level)	-4.676***	0.252+++ (level)	PB is I(0) according to 2 tests, I(1) according to PP test
UK	-3.576*** (level)	-3.187** (level)	0.433++ (level)	PB is I(0) according to 3 tests
IE	-5.701***	-5.403***	0.162+++	PB is I(1) according to 3 tests
PT	-3.185** (level)	-3.001** (level)	0.103+++ (level)	PB is I(0) according to 3 tests
ES	-6.432***	-6.287***	0.206+++ (level)	PB is I(1) according to 2 tests, I(0) according to KPSS test

***p<0.01, **p<0.05, *p<0.1 for ADF and PP tests (H0: series has a unit root); $^{+++}$p<0.01, $^{++}$p<0.05, $^{+}$p<0.1 for KPSS test (H0: series is stationary).
Source: Commission services.

Table A2.4: **Unit root / stationarity tests on other variables, period 1950-2013, intercept and automatic lag length selection (test statistics)**

	Expenditure gap		Output gap		Inflation		Real IIR	
	ADF test	**KPSS test**	**ADF test**	**KPSS test**	**ADF test**	**KPSS test**	**ADF test**	**KPSS test**
	H0: Var. is I(1)	H0: Var. is I(0)	H0: Var. is I(1)	H0: Var. is I(0)	H0: Var. is I(1)	H0: Var. is I(0)	H0: Var. is I(1)	H0: Var. is I(0)
BE	-5.826***	0.068+++	-4.171***	0.057+++	-3.596***	0.212+++	-3.49**	0.371++
DK	-5.373***	0.029+++	-4.527***	0.044+++	*-9.215****	0.400++	*-8.111****	0.211+++
DE	-6.393***	0.044+++	-8.735***	0.141+++	-6.528***	0.324+++	-6.162***	*0.500*+
FR	-5.147***	0.042+++	-5.177***	0.062+++	*-7.712****	0.422++	*-15.472****	*0.163*+++
IT	-6.93***	0.058+++	-5.309***	0.11+++	*-10.263****	0.189+++	*-10.082****	0.269+++
NL	-5.989***	0.037+++	-6.166***	0.069+++	-4.144***	0.312+++	-2.945**	*0.136*+++
AT	-6.805***	0.045+++	-4.592***	0.069+++	-5.575***	*0.298*+++	-5.667***	*0.406*++
FI	-4.629***	0.034+++	-5.248***	0.039+++	*-3.994****	*0.327*+++	-4.389***	*0.223*+++
SE	-4.756***	0.025+++	-4.916***	0.046+++	-3.86***	0.366++	-3.354**	0.434++
UK	-5.181***	0.066+++	-5.695***	0.067+++	-3.89***	0.228+++	-4.831***	0.445++
IE	-5.189***	0.043+++	-4.308***	0.055+++	*-5.895****	0.249+++	-3.819***	0.270+++
PT	-5.616***	0.036+++	-6.754***	0.044+++	*-14.957****	0.203+++	-3.545***	0.191+++
ES	-5.556***	0.053+++	-4.652***	0.047+++	*-7.559****	0.309+++	*-6.943****	0.387++

$^{***}p<0.01$, $^{**}p<0.05$, $^{*}p<0.1$ for ADF and PP tests (H0: series has a unit root); $^{+++}p<0.01$, $^{++}p<0.05$, $^{+}p<0.1$ for KPSS test (H0: series is stationary).
Note: the test statistics reported are for series tested in level (indicated that in most cases, they are stationary); except for the value in italic (series tested in first difference, indicating that they are I(1))). Both ADF and KPSS indicate that the series would be I(1) only in 2 cases (inflation in Finland and real implicit interest rate in France).

Source: Commission services.

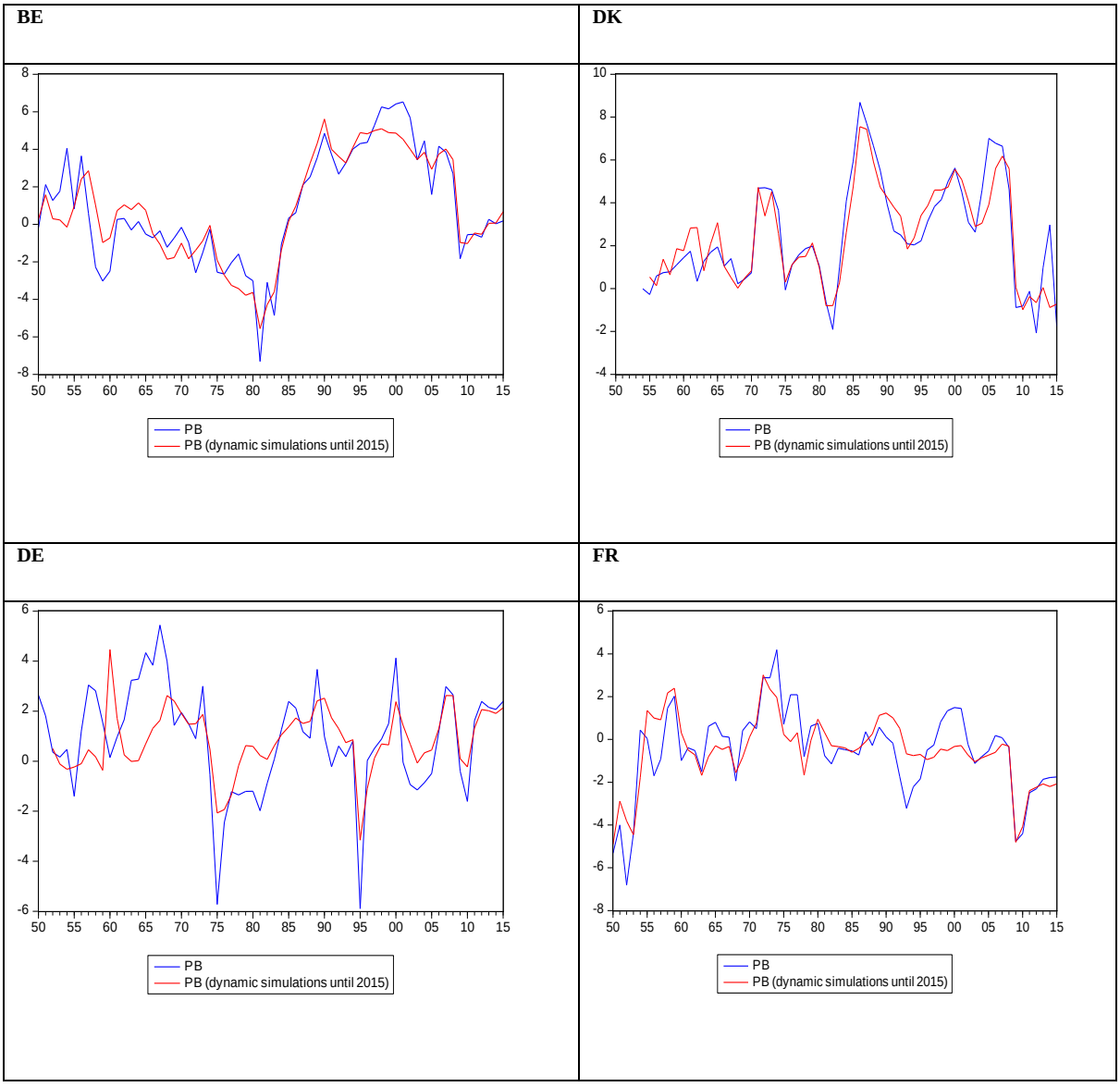
ANNEX 3 – ROBUSTNESS CHECKS

A3.1. DYNAMIC SIMULATIONS

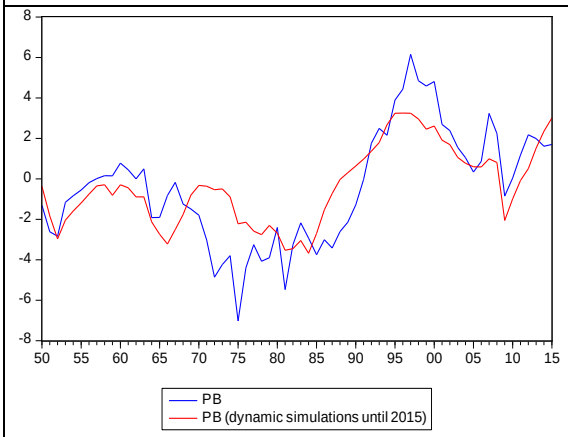
Country-specific FRFs

The graphs below display, by country, the simulated primary balance, taking into account the dynamic nature of the ECM specification used, versus the observed values of the primary balance.

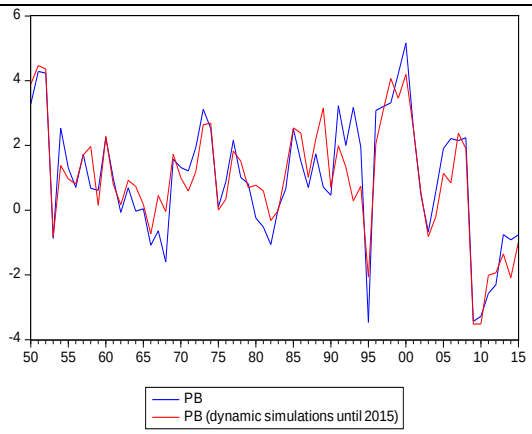
Graph A3.1: **Primary balance: observed and dynamically simulated (1950-2015)**



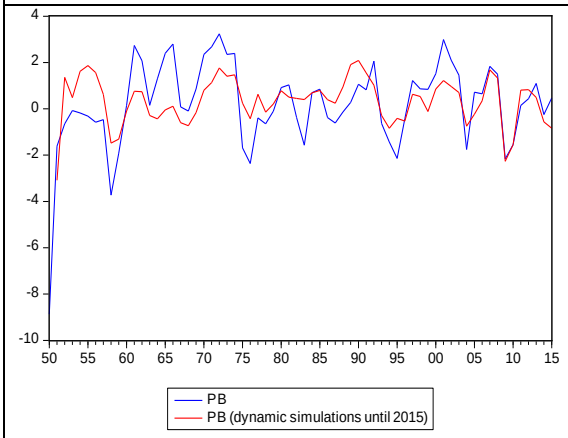
IT



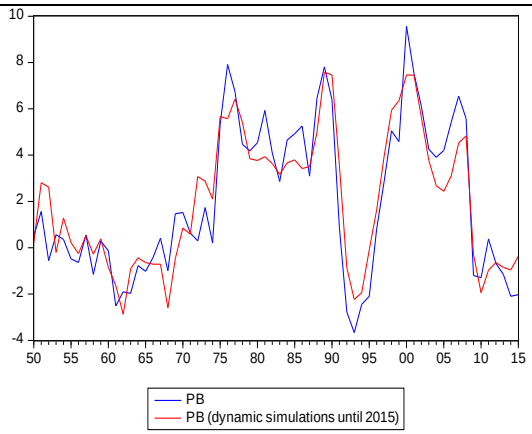
NL



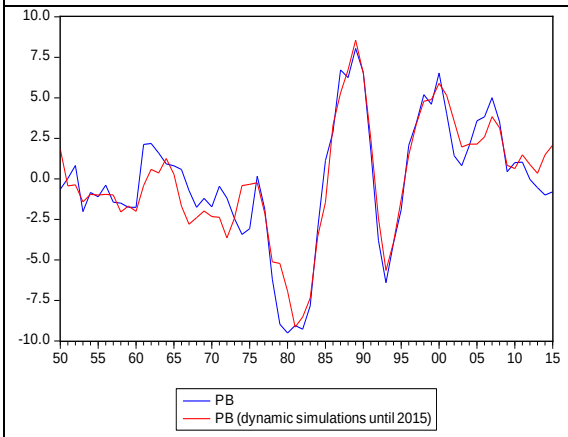
AT



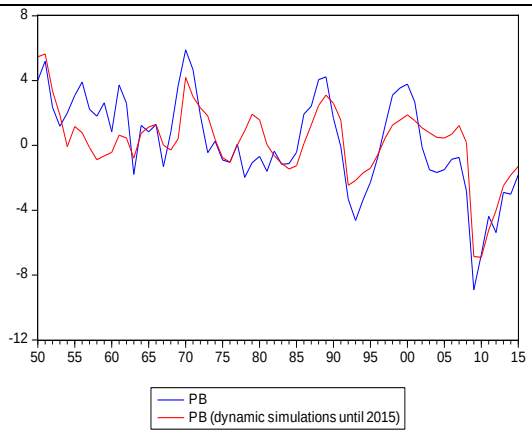
FI



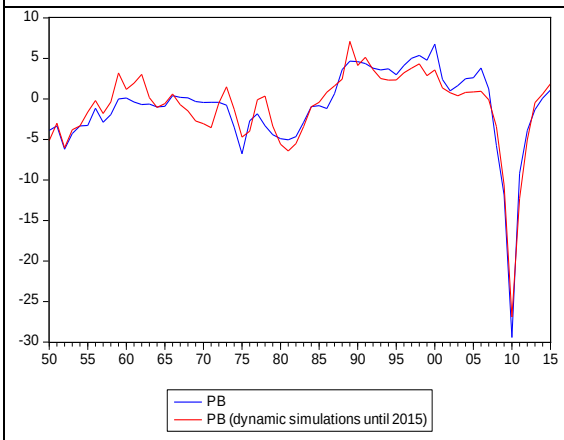
SE



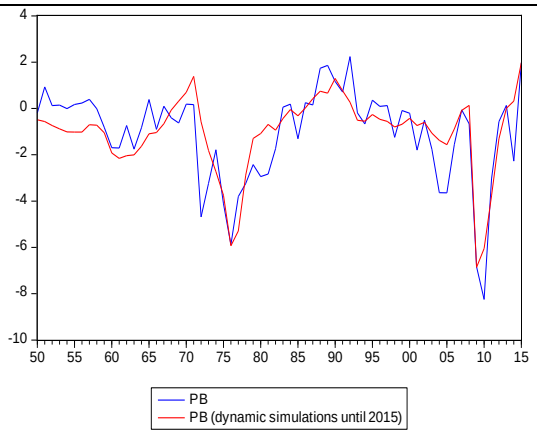
UK



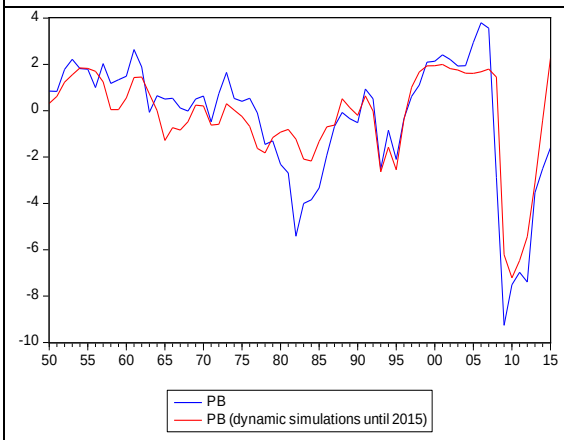
IE



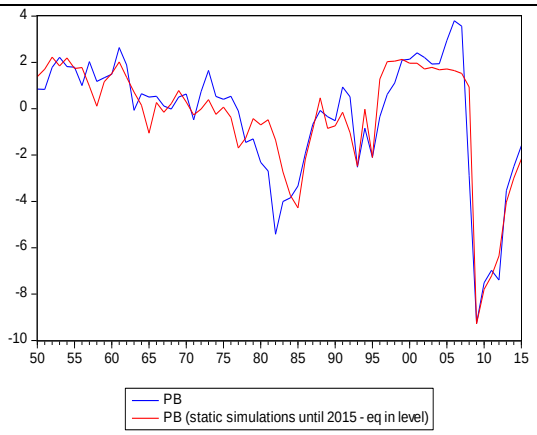
PT



ES – equation (1)



ES – equation (2) used for projections

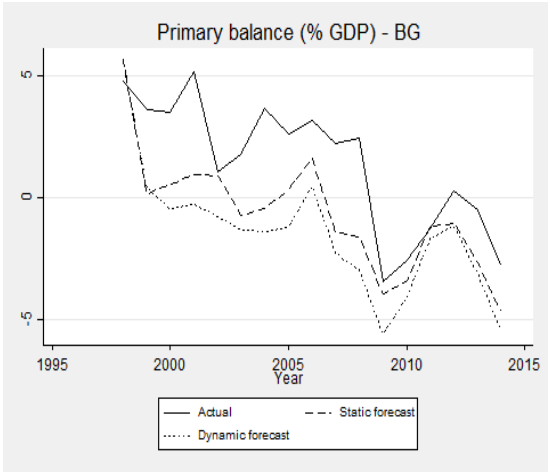


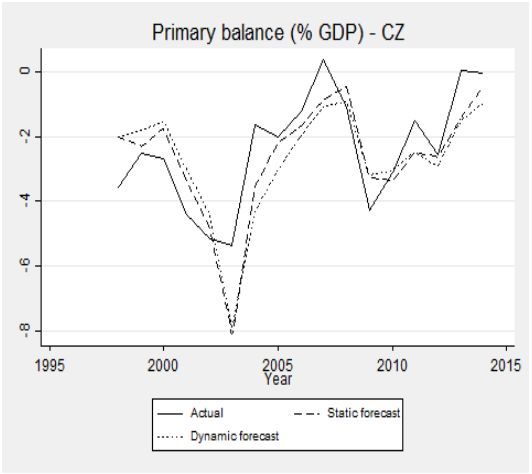
Source: Commission services.

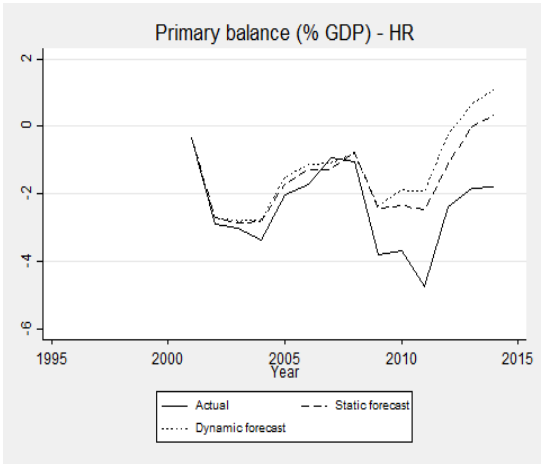
Panel FRF for CEECs

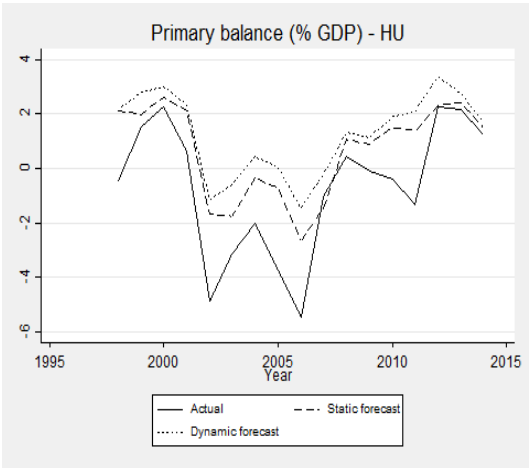
The performance of the estimated panel FRF in mirroring the historical behaviour of the primary balance for the countries in the sample has been assessed through the comparison between actual values of the primary balance and dynamic forecasts conducted over the past. For a panel of countries, results look satisfactory, with the exception of HR, which could be expected as the latter is one of the two countries in the sample with the smallest number of observations (EE being the country with the smallest number of observations of all, and for which the panel FRF is not used in debt projections exactly because of the very small number of observations, which make the panel FRF not representative of the country's fiscal reaction).

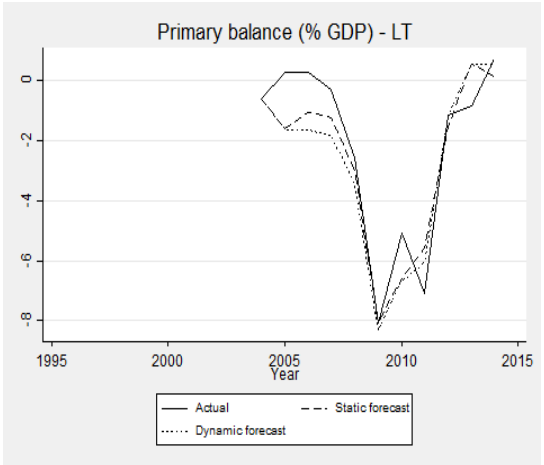
Graph A3.2: **Primary balance: observed and dynamically simulated (mid-1990s-2014)**

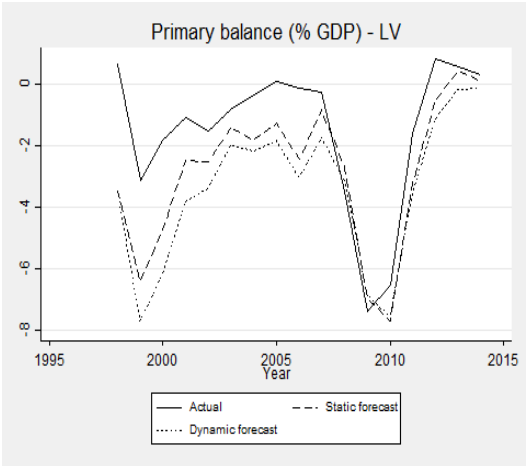


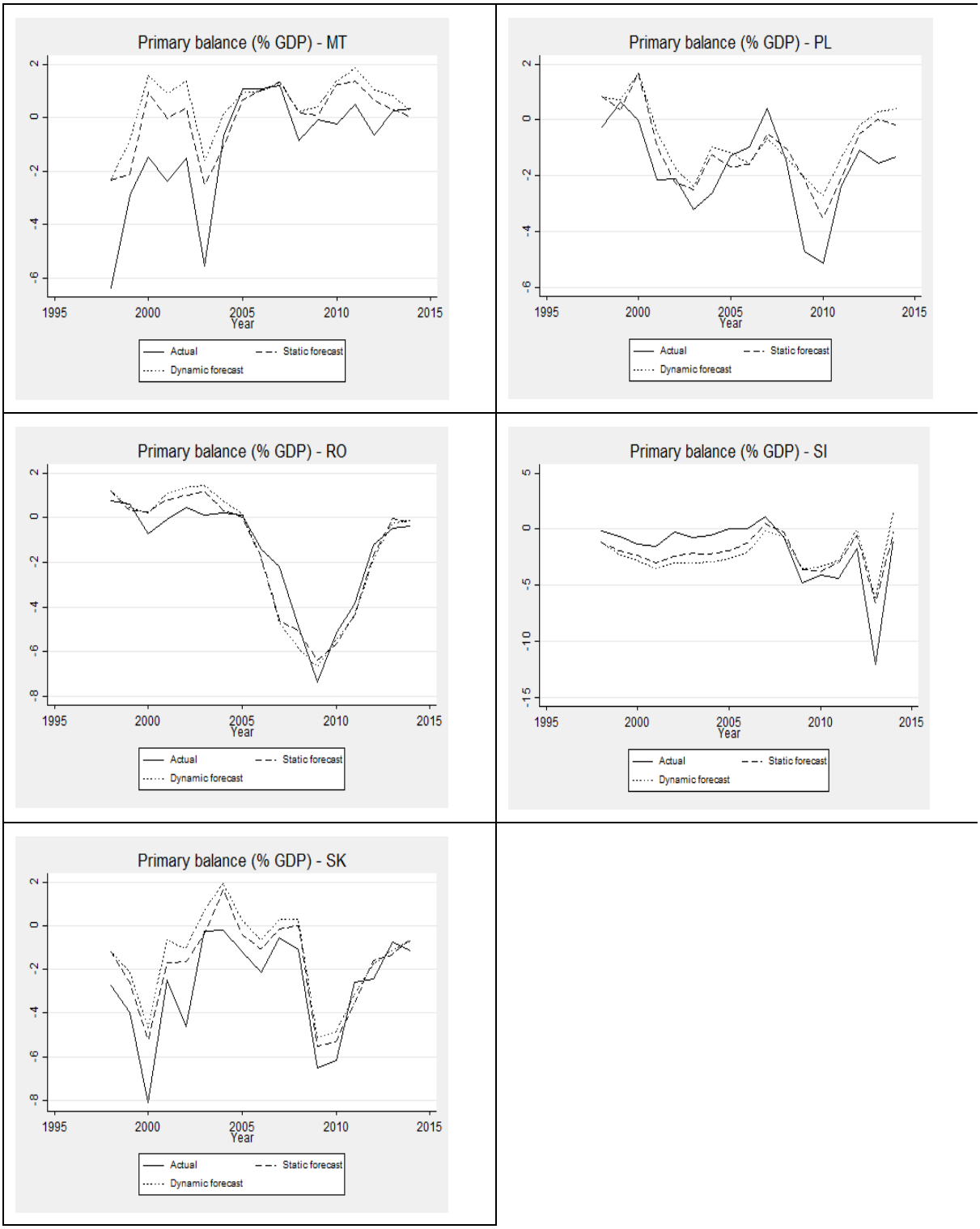












Source: Commission services.

A3.2. CROSS-COUNTRY ROBUSTNESS CHECKS FOR THE PANEL FRF

A cross-country robustness check was run on our preferred AB GMM model, by rerunning the regression eliminating one country at the time from the sample to see how estimates would change. As shown in Table A3.1, our estimates appear robust to this type of test.

Table A3.1: **Cross-country robustness checks (AB GMM estimations)**

VARIABLES	All 12 in	BG out	CZ out	EE out	HR out	HU out	LT out	LV out	MT out	PL out	RO out	SK out	SI out
Lagged primary balance	**0.310*** **	**0.304*** **	**0.310*** **	**0.310*** **	**0.281*** **	**0.350*** **	**0.299*** **	**0.307*** **	**0.321*** **	**0.298*** **	**0.308*** **	**0.313*** **	**0.323*** **
	(0.0543)	(0.0521)	(0.0516)	(0.0544)	(0.0520)	(0.0379)	(0.0577)	(0.0507)	(0.0613)	(0.0584)	(0.0584)	(0.0641)	(0.0557)
Lagged debt	**0.0643*** **	**0.0634*** **	**0.0618*** **	**0.0643*** **	**0.0702*** **	**0.0598*** **	**0.0662*** **	**0.0658*** **	**0.0562*** **	**0.0634*** **	**0.0663*** **	**0.0630*** **	**0.0670*** **
	(0.00917)	(0.0178)	(0.00986)	(0.00915)	(0.00848)	(0.00755)	(0.00942)	(0.00967)	(0.00956)	(0.0101)	(0.00867)	(0.0104)	(0.00970)
Expenditure gap	**-0.730*** **	**-0.728*** **	**-0.754*** **	**-0.730*** **	**-0.744*** **	**-0.696*** **	**-0.730*** **	**-0.759*** **	**-0.751*** **	**-0.724*** **	**-0.708*** **	**-0.691*** **	**-0.704*** **
	(0.0658)	(0.0829)	(0.0592)	(0.0660)	(0.0693)	(0.0661)	(0.0730)	(0.0767)	(0.0704)	(0.0655)	(0.0593)	(0.0863)	(0.0602)
Inflation	**0.0793*** **	**0.0825*** **	**0.0809*** **	**0.0792*** **	**0.0832** **	**0.0709** **	**0.0800*** **	**0.0771*** **	**0.0876*** **	**0.0700** **	**0.0774** **	**0.0843*** **	**0.0620** **
	(0.0289)	(0.0259)	(0.0268)	(0.0289)	(0.0324)	(0.0292)	(0.0299)	(0.0268)	(0.0250)	(0.0321)	(0.0370)	(0.0301)	(0.0253)
Constant	**-3.958*** **	**-4.152*** **	**-3.891*** **	**-4.022*** **	**-4.184*** **	**-3.536*** **	**-4.073*** **	**-4.156*** **	**-3.597*** **	**-3.814*** **	**-4.023*** **	**-3.831*** **	**-3.963*** **
	(0.537)	(0.765)	(0.544)	(0.541)	(0.590)	(0.386)	(0.584)	(0.558)	(0.523)	(0.554)	(0.585)	(0.636)	(0.658)
Observations	193	176	174	189	180	174	183	175	175	174	175	174	174
Number of id	12	11	11	11	11	11	11	11	11	11	11	11	11

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Source: Commission services.

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