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Master's thesis

Estimating the Sustainable Level of the General Government Debt in the European Union

Tvaraus valdžios sektoriaus skolos lygio nustatymas Europos Sąjungoje

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Santrauka

Šiame darbe vertinamas tvarus valdžios sektoriaus skolos lygis Europos Sąjungos šalims. Šalys skirstomos į pogrupius ir, vertinant fiskalinio atsako funkciją grupėms, bandoma nustatyti koks yra skolos lygis, kurį pasiekus galimybės didinti pirminio balanso rodiklį augant skolai pradeda mažėti. Analizei naudojami 2000–2019 metų metiniai duomenys ir sudaromi paneliniai modeliai. Vertinimo metu nustatyta, kad skolos limitai visoms vertinamoms grupėms yra aukšti, tačiau žemesni mažoms ir atviroms Baltijos šalių ekonomikoms, nei kitoms šalims. Rezultatai taip pat remia hipotezę, kad homogeniškesnių šalių grupavimas leistų tiksliau įvertinti parametrus.

Raktiniai žodžiai: fiskalinio atsako funkcija, tvarus skolos lygis, Europos Sąjunga, panelinių duomenų modelis

Estimating the sustainable level of the general government debt in the European Union

Abstract

This thesis assesses the sustainable level of government debt to the countries of the European Union. The countries are divided into subgroups and, an attempt is made to determine the level of debt at which a government's ability to increase the primary balance ratio as debt increases begins to decline. For the analysis, annual data for 2000–2019 are used, and panel models are estimated. The assessment found that the debt limits for all groups are high, but lower for small and open economies of the Baltic countries. Results also support the hypothesis that grouping more homogeneous countries could lead to more precise estimates.

Key words: fiscal reaction function, sustainable debt level, European Union, panel data model

Content

1 Introduction

While the euro area's sovereign debt crisis and the fallout of 2008 crash had sparked interest in how much debt is too much, the concerns over sustainability are as relevant as ever because of the COVID-19 pandemic, which has resulted in an increase of eurozone debt from 2019 fourth-quarter level of 84.0% GDP to the most recent figure of 95.1% GDP in 2020 second quarter. A key issue during a crisis is what room for fiscal manoeuvre countries have and what adjustments are needed to maintain or achieve debt sustainability.

There is no single definition of debt sustainability. International monetary fund (IMF) defines debt sustainability as 'a situation in which a borrower is expected to be able to continue servicing its debts without an unrealistically large future correction to the balance of income and expenditure' (IMF, 2012, p. 4). Organization for economic cooperation and development (OECD) has published a basic framework upon which fiscal sustainability can be assessed. It includes four categories (Shaw, 2017):

1. Solvency – The ability of government to pay its financial obligations.
2. Growth – a fiscal policy that sustains economic growth.
3. Stability – the capacity of government to meet future obligations with existing tax burdens.
4. Fairness – the capacity of government to pay current obligations without shifting the cost to future generations.

This work concerns the debt aspect of fiscal sustainability and looks at it from the standpoint of two dimensions – solvency and economic growth. The themes explored are debt limit estimation using fiscal reaction function and optimal debt targets. Fiscal reaction function describes how a country's primary balance responds to increases in debt-to-GDP ratio. According to Bohn (1998), debt is sustainable if there is a positive relationship between debt and primary balance. Some studies (Ghosh, Kim, Mendoza, Ostry, and Qureshi (2013), Checherita-Westphal and Žďárek (2017)) point to the possibility of fiscal fatigue, meaning that, at very high debt ratios, the fiscal effort must be so large that it becomes untenable.

If a country does not have fiscal space, which in this thesis is defined as the difference between the debt-to-GDP ratio and the debt limit, related to the phenomenon of fiscal fatigue, counter-cyclical fiscal policy during a recession cannot be implemented. Prudent fiscal policy has to take into account the sustainability of debt, but also should not be too restrictive as it would stifle investment and impede economic growth. While the Stability and Growth pact (Warin, 2016) specifies the debt limit 60% of GDP, this criterion is the same for all euro area countries and does not take into account the specifics of each country.

The purpose of this thesis is to estimate debt targets and debt limits for a select group of countries in the European Union using Ghosh et al. (2013) non-linear representation of the fiscal reaction function.

Tasks include reviewing the relevant literature, estimating the parameters of FRF's and deriving debt limits and targets. The outline of the thesis reflects the tasks and is as follows:

- Chapter 2 describes the relevant literature;
- Chapter 3 presents the theoretical framework;
- Chapter 4 discusses empirical results;
- Chapter 5 concludes.

2 Literature Review

This work concerns the debt aspect of fiscal sustainability and looks at it from two dimensions – solvency and economic growth. The articles in this literature review are mostly working papers of the IMF, the European Commission, the European Central Bank, and other international institutions. The themes explored are debt limit estimation using fiscal reaction functions and optimal debt targets.

2.1 Determining Debt Limits

One way to empirically study fiscal sustainability is by using the fiscal reaction function (FRF), which was coined in the seminal paper by Bohn (1998). The author shows that the US satisfies the intertemporal budget constraint[1] and that the condition for sustainability is that the government reacts to increases in government debt by reducing the primary deficit[2] or increasing the primary surplus. It should be noted that in his model, connections are contemporaneous. The concept of the FRF has been used for a wide variety of applications since then. Medeiros (2012) has used VAR models, FRF's and debt level simulations on panel data from 15 European Union countries to conclude that at high debt levels that primary balances show fiscal fatigue and (partial) mean reversion to past trends. Baldi and Staehr (2013) have found that the underlying fiscal reaction across Europe has become more prudent after the outbreak global financial crisis in 2008. Checherita-Westphal and Ždárek (2017) assess the current account balance impact on FRF's. Positive coefficients for this variable confirm the hypothesis that there is a strong interdependent relationship between the general government balance and the current account balance known as the twin deficits hypothesis.

Another application which is most relevant to the questions posed in this thesis is the estimation of debt thresholds and debt limits in an attempt to measure fiscal space. One of the first articles written with this kind of application is Ghosh et al. (2013). In this paper, the authors estimate a debt limit corresponding to a debt level beyond which debt grows expo-

[1]The government's intertemporal budget constraint requires that the present value of current and future taxes must be sufficient to cover the present value of current and future government spending plus the initial stock of government debt.

[2]Net of interest payments.

nentially by using a cubic representation of the FRF and interest payment schedule, which is in line with the findings that the size of primary balance response might be stronger when the debt ratio exceeds a given threshold, but eventually begins to weaken, and decreases at very high debt levels. The form of the function was obtained as a stylized fact plotting the historical behaviour of primary balance-to-GDP ratio against lagged debt-to-GDP ratio for a broad panel of world economies for 1970-2007. For the countries in the sample, the estimated debt limit ranges from 150 to 250% of GDP. Fall, Bloch, Fournier, and Hoeller (2015) first determine the debt threshold beyond which the country loses market access and then, using simulations, arrive at prudent debt targets, which ensure that that level would not be reached. Because the time series methodology is used for estimation of FRF's, due to the scarcity of data panel models using annual or quarterly data are popular. Berti et al. (2016) note that separate models for countries are superior to panel models because evaluations show that there are significant differences between countries. Due to the scarcity of available data and short samples, a panel data approach is used in this thesis, however, an effort is made to account for heterogeneity by exploring groups of more similar countries.

2.2 Optimal Debt Targets

Going beyond concerns for fiscal sustainability, high levels of debt can impede growth prospects. Reinhart and Rogoff (2010) published a study in which they postulated, that debt beyond 90% GDP impedes growth. Examples of articles concerning this phenomenon are relatively abundant. Cecchetti, Mohanty, and Zampolli (2011) estimate that the threshold of public debt above which negative effects emerge is around 85% of GDP. Baum, Checherita-Westphal, and Rother (2013) also conclude that high levels of debt (above 95%) harm growth. However, Pescatori et al. (2014) do not find evidence of any threshold after which medium-term growth prospects are dramatically compromised. Egert (2013) indicates that a universal non-linear relationship between debt and growth is not robust. Checherita-Westphal et al. (2012) have found that the euro area should target debt levels of around 50% of GDP if member states are to have common targets.

In this thesis, we define the target level of debt-to-GDP as the point where the difference between the FRF and the interest payment schedule is the highest.

3 Modelling Fiscal Reaction Functions, Debt Limits and Optimal Debt Targets

In deriving the debt limit Ghosh et al. (2013) use a standard government budget constraint:

$$d_{t+1} - d_t = (r_t - g)d_t - s_{t+1}, \tag{1}$$

where d_t is general government debt-to-GDP ratio at the end of period t, g – real GDP growth, s_t – primary balance-to-GDP ratio, r_t – real interest rate.

Fiscal reaction function:

$$s_{t+1} = \mu_t + f\left(d_t\right) + \varepsilon_{t+1}, \tag{2}$$

where μ_t are systemic variables that affect the primary balance and are not directly controlled by the government, like output gap, government expenditure gap[3] etc., $f(d_t)$ is the response of the primary balance to lagged debt, ε_{t+1} is the error term.

In this framework, an assumption is made that investors lend to the government at the risk-free interest rate r^* until the debt limit d'' is reached and then it loses access to the market. In reality, the interest rate should depend on the debt level, but we do not take that into account in this thesis. Since the debt limit is the highest point at which the obligations are still being met, it is the highest root of :

$$\hat{\mu}_t + \hat{f}\left(d\right) = \left(r^* - g\right)d \tag{3}$$

From the assumption that $\hat{f}(d)$ is continuously differentiable and:

$$\hat{\mu}_t + \hat{f}(d^m) - \bar{\varepsilon} \geq (r^* - g)d^m \; and \; \hat{f}'(d) < r^* - g, \; \forall d > d^m, \tag{4}$$

where ε is an independent and identically distributed (i.i.d.) shock to the primary balance with the distribution function $G(\varepsilon)$ defined over the finite support $[-\bar{\varepsilon}, \bar{\varepsilon}]$ with $\bar{\varepsilon} > 0$.

[3] Inclusion of these variables lead to the concept of structural balance, which has also been used in literature for FRF estimation

While both sides of the previous equation are increasing in d, by the assumption in 4, the left-hand side rises more slowly than the right-hand side for $d > d^m$. Hence, beyond d'', the primary balance is never sufficient to meet the interest payment, debt grows continuously and the government necessarily defaults, which is the definition of the debt limit.

There exists another positive root denoted d' and it is the long-run public debt ratio to which the economy converges as long as debt does not cross the limit d''.

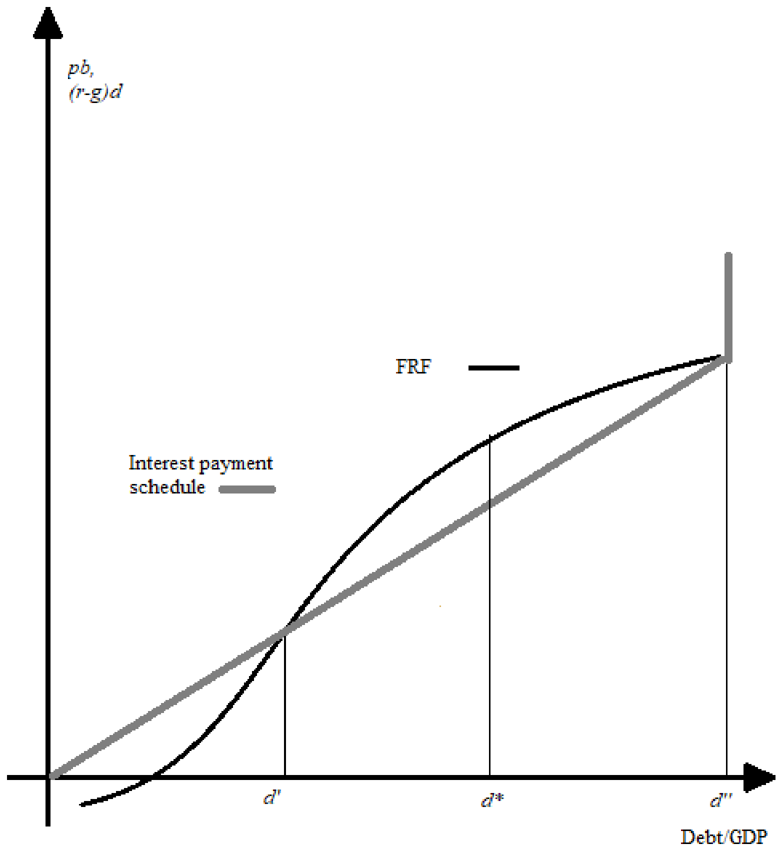

Figure 1: Fiscal reaction function and interest payment schedule graph

The optimal debt target d', using the FRF framework can be defined as the point at which the positive difference between the FRF and interest payment schedule is the highest. This point, assuming the debt is reasonably well invested, should ensure that an attempt to consolidate debt would not negatively impact economic growth.

4 Models and Data

The empirical part of this thesis includes results from pooled, fixed effects and, allowing for the presence of potentially endogenous variables, fixed effects with instrumental variables panel models. Fixed effects estimator with instrumental variables is commonly used in literature (e.g. Ghosh et al. (2013), Checherita-Westphal and Žďárek (2017), Baldi and Staehr (2013)). We choose to use annual data because it is more informative for the analysis of fiscal policy since it reflects budgetary years better than higher frequency data. The data is also constrained by data availability for countries that have joined the EU more recently. For better comparability, the same time window is chosen of years spanning from 2000 to 2019. The choice of the panel data approach is in part a result of the small sample.

Generally, the sequence of steps while modelling would start from the pooled OLS model and then if Chow test rejects the null hypothesis of homogeneous slope coefficients, a fixed and/or random effects model would be estimated. Considering the large differences between the results from the estimated models, we present all of them in the empirical part.

The general equation for the empirical model is an extension of the relationship given by (2):

$$s_{i,t} = \mu + \beta_0 s_{i,t-1} + \beta_1 d_{i,t-1} - \beta_2 d^2_{i,t-1} - \beta_3 d^3_{t-1} + \sum_{j=1}^{k} \gamma_j X_{j,i,t}[+\delta_i] + \varepsilon_{i,t}, \tag{5}$$

where $s_{i,t}$ is the primary balance as a share of GDP, $s_{i,t-1}$ is the lagged value of primary balance, $d_{i,t-1}$, $d^2_{i,t-1}$ and $d^3_{i,t-1}$ are lagged debt-to-GDP ratios and their transformations, $X_{j,i,t}$ include macroeconomic and institutional variables, δ_i represent country fixed effects (by the definition, these are not included in a pooled model), $\varepsilon_{i,t}$ is the error term.

5 Empirical Results

The approach taken in this thesis is to model FRF's for groups of countries because a single country generally has not experienced both inflexion points so it is not viable to determine the debt limit. Additionally, we assume that there are qualitative differences between groups of countries - we would expect that countries with more mature economies of Western Europe would be able to carry a bigger debt burden than their Central and Eastern European counterparts. This approach is informed mainly by Berti et al. (2016). Countries are separated into 4 groups. We use panel data models (5) to estimate the necessary coefficients. The figures for interest rate-growth differential $r - g$ are derived from historical data averaging.

First, we present the estimated FRF's and then calculate the debt thresholds.

5.1 Fiscal Reaction Functions Estimates

In this section, we present three varieties of estimated panel data models - pooled, fixed effects and fixed effects with instrumental variables, where lagged primary balance was instrumented by its lag.

In addition to lagged primary balance (l_PB), lagged debt and its transformations (l_DEBT, l_DEBT^2, l_DEBT^3), some models include additional explanatory variables, like output gap (OG), government expenditure gap (EXPEND_GAP), dummy for 2008-2010 (crisis), fiscal rules index (FRI), trade openness (TRADE_OPENNESS), harmonised index of consumer prices (HICP), real GDP growth (gdp_growth), age dependency ratio (AGE_DEP), current account balance-to-GDP ratio (CABY) and political stability index (PSI).

5.1.1 Baltic countries

Baltic countries – Estonia, Latvia and Lithuania– are often analysed together as they are all small open economies and culturally linked. We present results for four estimated models - pooled (POLS), two variants of fixed effects (FE1, FE2), and fixed effects with instrumental variables (FEIV).

	POLS	FE1	FE2	FEIV
(Intercept)	2.309*			
	(0.869)			
l_PB	0.519***	0.293**	0.436***	0.731**
	(0.082)	(0.106)	(0.095)	(0.229)
l_DEBT	−0.427**	−0.526*	−0.267	−0.174
	(0.154)	(0.198)	(0.246)	(0.256)
l_DEBT^2	0.016*	0.013	0.009	0.006
	(0.007)	(0.008)	(0.010)	(0.010)
l_DEBT^3	−0.000	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)	(0.000)
OG	29.289***	42.264***		23.850*
	(5.515)	(6.199)		(9.858)
EXPEND_GAP	−30.314***	−28.196***		−28.131***
	(3.639)	(3.769)		(4.461)
HICP		−0.252**		
		(0.085)		
FRI		0.645*		
		(0.278)		
crisis			−3.224***	
			(0.592)	
R^2	0.803	0.832	0.691	0.794
Adj. R^2	0.779	0.796	0.647	0.754
Num. obs.	57	57	57	51

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 1: Statistical models: Baltic countries

In all specifications, we can see that the FRF has the necessary form and some coefficients for lagged debt are statistically significant.

5.1.2 Other small economies

The group of countries in this section is Slovakia, Slovenia, Croatia, Malta, Cyprus and Bulgaria. Their economies are similar in size and rely on exports.

For the countries in this section, the following model results are presented – pooled (POLS), fixed effects (FE), and fixed effects with instrumental variables (FEIV).

In all specifications, we can see that the FRF has the necessary form, though coefficients for lagged debt are not statistically significant in any of the specifications.

	POLS	FE	FEIV
(Intercept)	1.706		
	(1.562)		
l_PB	0.544***	0.492***	0.821***
	(0.055)	(0.060)	(0.142)
l_DEBT	−0.153	−0.004	−0.040
	(0.096)	(0.116)	(0.133)
l_DEBT^2	0.003	0.001	0.001
	(0.002)	(0.002)	(0.002)
l_DEBT^3	−0.000	−0.000	−0.000
	(0.000)	(0.000)	(0.000)
OG	42.711***	45.339***	30.970**
	(9.176)	(9.402)	(11.862)
EXPEND_GAP	−35.214***	−33.912***	−38.298***
	(4.087)	(4.107)	(4.685)
FRI	0.251	0.115	
	(0.142)	(0.193)	
crisis	−0.840	−0.787	
	(0.463)	(0.472)	
TRADE_OPENNESS		0.004	
		(0.009)	
R^2	0.710	0.687	0.635
Adj. R^2	0.688	0.643	0.593
Num. obs.	114	114	108

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 2: Statistical models: other small and open economies

5.1.3 GIIPS

The group in this section includes Greece, Italy, Ireland, Portugal, and Spain. Data for Greece from 2015 is not included, as, at that point, the country's budget surpluses to a large extent might have been determined by international agreements.

For the countries in this section, the following model results are presented – pooled (POLS), fixed effects (FE), and fixed effects with instrumental variables (FEIV), where lagged primary balance was instrumented by its lag.

In all specifications, we can see that the FRF has the necessary form, though coefficients for lagged debt are not statistically significant in any of the specifications.

	POLS	FE	FEIV
(Intercept)	-0.529		
	(3.292)		
l_PB	0.511^{***}	0.652^{***}	0.560^{**}
	(0.069)	(0.089)	(0.173)
l_DEBT	-0.090	-0.066	-0.130
	(0.119)	(0.163)	(0.191)
l_DEBT^2	0.001	0.001	0.002
	(0.001)	(0.002)	(0.002)
l_DEBT^3	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
HICP	0.849^{***}		
	(0.246)		
FRI	0.687^{*}		
	(0.317)		
crisis	-4.417^{***}		
	(0.845)		
R^2	0.685	0.435	0.418
Adj. R^2	0.658	0.380	0.357
Num. obs.	91	91	86

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 3: Statistical models: GIIPS

5.1.4 EA12

The group in this section includes the first 12 euro area countries from Western Europe – Austria, Belgium, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal and Spain. Once again, data for Greece from 2015 is not included, as, at that point, the country's budget surpluses might have been determined by international agreements.

The FRF has the necessary form in all specifications, though here too coefficients for lagged debt are not statistically significant in any of the specifications. The estimates for all models for debt variables are close.

	POLS	FE	FEIV
(Intercept)	-0.083		
	(0.965)		
l_PB	0.664^{***}	0.528^{***}	0.550^{***}
	(0.049)	(0.029)	(0.097)
l_DEBT	-0.031	-0.043	-0.048
	(0.040)	(0.053)	(0.087)
l_DEBT^2	0.001	0.000	0.001
	(0.001)	(0.001)	(0.001)
l_DEBT^3	-0.000	-0.000	-0.000
	(0.000)	(0.000)	(0.000)
CABY	0.127^{***}		
	(0.034)		
EXPEND_GAP		-56.971^{***}	
		(3.153)	
HICP		0.480^{***}	
		(0.084)	
TRADE_OPENNESS		0.015^{*}	
		(0.006)	
gdp_growth		0.207^{***}	
		(0.033)	
crisis		-0.919^{***}	
		(0.259)	
OG			34.832^{***}
			(10.544)
R^2	0.553	0.869	0.458
Adj. R^2	0.542	0.856	0.413
Num. obs.	216	224	212

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 4: Statistical models: 12 EA members

5.1.5 European Union countries

In this section, previous estimation techniques are used for the whole dataset of 27 countries that belong to the EU.

As we can see from the table on model estimates, the choice to separate countries into more homogeneous groups might have merit, considering that only the pooled model for the whole dataset has the necessary signs for debt limit and debt target estimation. This result supports the hypothesis that the countries in this set are too heterogeneous for the relevant purposes and together mask the non-linear relationship between lagged debt and primary balance. This result supports the approach we use.

	POLS	FE	FEIV
(Intercept)	-2.276^{**}		
	(0.853)		
l_PB	0.592^{***}	0.562^{***}	0.580^{***}
	(0.025)	(0.025)	(0.058)
l_DEBT	-0.010	0.006	0.076^{*}
	(0.017)	(0.027)	(0.036)
l_DEBT^2	0.000	0.000	-0.000
	(0.000)	(0.000)	(0.000)
l_DEBT^3	-0.000	-0.000	0.000
	(0.000)	(0.000)	(0.000)
OG	32.510^{***}	25.116^{***}	21.428^{***}
	(4.002)	(4.547)	(5.078)
EXPEND_GAP	-33.024^{***}	-31.060^{***}	
	(2.071)	(2.011)	
HICP	0.084^{**}	0.102^{**}	
	(0.030)	(0.031)	
crisis	-1.446^{***}	-1.224^{***}	
	(0.203)	(0.221)	
AGE_DEP	0.060^{**}		
	(0.023)		
CABY	0.048^{**}		
	(0.017)		
TRADE_OPENNESS	0.003^{*}	0.010^{*}	
	(0.001)	(0.005)	
PSI	0.481^{*}		
	(0.228)		
gdp_growth		0.068^{*}	
		(0.028)	
R^2	0.755	0.717	0.447
Adj. R^2	0.749	0.696	0.409
Num. obs.	485	509	482

$^{***}p < 0.001$; $^{**}p < 0.01$; $^{*}p < 0.05$

Table 5: Statistical models: EU

5.2 Estimates of Debt Thresholds

Debt thresholds d', d^* and d'' were estimated using the FRF's discussed in the previous section. We denote the interest rate-growth differential by used in deriving the relevant points as $\bar{r} - \bar{g}$. Then the equation we need to solve is:

$$\hat{\mu} + f(\hat{d}) = (\bar{r} - \bar{g})d.$$

From the form of the FRF follows:

$$\hat{\mu} + \hat{\beta}_1 d + \hat{\beta}_2 d^2 + \hat{\beta}_3 d^3 = (\bar{r} - \bar{g})d$$

Therefore, we need to solve this equation:

$$\hat{\mu} + (\hat{\beta}_1 - (\bar{r} - \bar{g}))d + \hat{\beta}_2 d^2 + \hat{\beta}_3 d^3 = 0$$

Since output gaps and expenditure gaps tend to 0 in the long run, the coefficients for these variables are not taken into account when calculating $\hat{\mu}$. This also applies to dummy variables. For variables in $\hat{\mu}$ whose effects can not reasonably be assumed to be 0, historical averages are used. Complex roots are not reported.

5.2.1 Baltic countries

The estimates for the long-run debt-to-GDP ratio, debt target and debt limit are in Table 6, where the interest rate-growth differential is calculated by averaging data from 2008 to 2019. We can see that depending on the model used, the numbers are quite different. The pooled model seems to give the most conservative estimates, while fixed effects with instrumental variables give the highest numbers. The effect of different FRF's is noticeable, but individual country effects on the final result seem to be small.

Table 6: Debt thresholds: Baltic countries

Model	Country	d'	d^*	d''
POLS		-5.94	76.82	121.3
FE1	Lithuania		119.53	187.37
FE1	Latvia		119.53	187
FE1	Estonia		119.53	186.47
FE2	Lithuania	-3.29	108.9	174.7
FE2	Latvia	-2.59	108.9	174.55
FE2	Estonia	-3.59	108.9	174.76
FEIV	Lithuania	-0.43	126.23	203.69
FEIV	Latvia	-0.02	126.23	203.58
FEIV	Estonia	-1.32	126.23	203.92

5.2.2 Other small economies

The estimates for the long-run debt-to-GDP ratio, debt target and debt limit are in Table 7, where the interest rate-growth differential is also calculated using data from 2008 to 2019. The difference between models persists in this group as well. The estimates are higher than for Baltic countries and POLS results in more conservative estimates.

Table 7: Debt thresholds: other small open economies

Model	Country	d'	d^*	d''
POLS		31.89	112.92	159.77
FE	Bulgaria	-6.4	184.66	295.01
FE	Cyprus	16.37	184.66	289.57
FE	Croatia	15.1	184.66	289.94
FE	Malta	15.6	184.66	289.79
FE	Slovakia	19.41	184.66	288.68
FE	Slovenia	13.24	184.66	290.45
FEIV	Bulgaria	-12.5	173.67	267.05
FEIV	Cyprus	18.31	173.67	263.59
FEIV	Croatia	12.28	173.67	264.65
FEIV	Malta	5.21	173.67	265.61
FEIV	Slovakia	4.5	173.67	265.69
FEIV	Slovenia	4.28	173.67	265.72

5.2.3 GIIPS

The estimates for the long-run debt-to-GDP ratio, debt target and debt limit are in Table 8, where the interest rate-growth differential is calculated using data from 2012 to 2019. We can see that depending on the model used, the numbers are quite different. Pooled model is the most optimistic when considering the debt limit. Estimates for d^* are close for all models.

Table 8: Debt thresholds: GIIPS

Model	Country	d'	d^*	d''
POLS		42.91	160.93	225.68
FE	Greece		164.34	195.26
FE	Ireland	80.45	164.34	220.81
FE	Italy		164.34	216.69
FE	Portugal		164.34	217.3
FE	Spain	73.38	164.34	223.39
FEIV	Greece	133.9	160.83	184.07
FEIV	Ireland	91.32	160.83	208.48
FEIV	Italy	90.66	160.83	208.75
FEIV	Portugal	93.99	160.83	207.35
FEIV	Spain	82.88	160.83	211.68

5.2.4 EA12

The estimates for the long-run debt-to-GDP ratio, debt target and debt limit are in Table 9, where the interest rate-growth differential is calculated using data from 2009 to 2019. POLS seems to give the most conservative estimates, while FE has the highest numbers for debt limits and debt targets. The estimates are also much higher than in the previous groups.

Table 9: Debt thresholds: EA12

Model	Country	d'	d^*	d''
POLS			187.74	288.32
FE	Austria		375.71	571.04
FE	Belgium		375.71	567.36
FE	Finland		375.71	574.28
FE	France		375.71	569.86
FE	Germany		375.71	574.07
FE	Greece	43.01	375.71	561.58
FE	Ireland	60.69	375.71	558.56
FE	Italy		375.71	572.76
FE	Luxembourg	76.53	375.71	555.14
FE	Netherlands		375.71	568.62
FE	Portugal		375.71	568.05
FE	Spain		375.71	568.53
FEIV	Austria	44.28	224.88	331.64
FEIV	Belgium	60.12	224.88	327.62
FEIV	Finland	24.3	224.88	335.09
FEIV	France	49.82	224.88	330.36
FEIV	Germany	26.02	224.88	334.86
FEIV	Greece	79.91	224.88	321.11
FEIV	Ireland	89.03	224.88	317.58
FEIV	Italy	34.96	224.88	333.48
FEIV	Luxembourg	98.76	224.88	313.44
FEIV	Netherlands	55.12	224.88	329.01
FEIV	Portugal	57.39	224.88	328.39
FEIV	Spain	55.47	224.88	328.91

Considering the properties of the models, results should be interpreted with caution.

5.2.5 Effect of changing r-g for EA12

Debt thresholds for EA12 obtained using $r-g$ figure which was used for the GIIPS section are shown in Table 10. We can see that the estimates vary not only because of different parameters of the FRF's but are also very sensitive to changes in $r-g$.

Table 10: Debt thresholds: EA12

Model	Country	d'	d^*	d''
POLS		41.77	149.84	210.66
FE	Austria		328.51	476.32
FE	Belgium	64.37	328.51	469.74
FE	Finland		328.51	481.92
FE	France		328.51	474.23
FE	Germany		328.51	481.56
FE	Greece	120.14	328.51	458.9
FE	Ireland	138.65	328.51	452.93
FE	Italy		328.51	479.32
FE	Luxembourg	157.25	328.51	445.83
FE	Netherlands		328.51	472.01
FE	Portugal		328.51	471
FE	Spain		328.51	471.86
FEIV	Austria	91.72	197.91	269.48
FEIV	Belgium	111.44	197.91	260.8
FEIV	Finland	71.53	197.91	276.25
FEIV	France	98.28	197.91	266.82
FEIV	Germany	73.01	197.91	275.83
FEIV	Greece		197.91	
FEIV	Ireland	160.21	197.91	230.66
FEIV	Italy	81.55	197.91	273.16
FEIV	Luxembourg		197.91	
FEIV	Netherlands	104.89	197.91	263.9
FEIV	Portugal	107.82	197.91	262.54
FEIV	Spain	105.34	197.91	263.7

5.3 Policy implications

Concerns over the sustainability of government finances have come into prominence after the 2008 crash when budget deficits ballooned. Eventually, it led to the implementation of austerity policies in many European countries. Mark Blyth (Blyth, 2013) claims that austerity fails to restore confidence and promote growth. If we take the same position, the only reason to implement this policy would be if you have no fiscal space left. The results of this thesis would support the idea, given past behaviour, countries for which thresholds have been estimated to have plenty of fiscal space left. However, these figures are quite high.

One popular heterodox macroeconomic theory that would support the sustainability of higher government debts is the Modern Monetary Theory (MMT). It synthesizes ideas from the State Theory of Money of Georg Friedrich Knapp (Knapp, 1924), Credit Theory of Money of Alfred Mitchell-Innes (Innes, 2004), the functional finance proposals of Abba Lerner as well as Hyman Minsky's and Wynne Godley's views. According to MMT, taxation and its legal tender enable power to discharge debt and establish fiat money as currency, giving it value by creating demand for it in the form of a private tax obligation. This view coincides with what David Graeber (Graeber, 2011) has found about the emergence of money from a historical perspective. MMT maintains that government deficit or surplus is a tool to manage inflation and unemployment and not in itself the means of funding government activities, hence the main constraint on increasing debt is related to inflation.

Critics of MMT point out that while if $r < g$ then debt is not much of a problem, but if $r > g$ there is a possibility of debt snowball and the debt-to-GDP ratio would grow and eventually the government would have to run large primary surpluses to stabilise the debt level. In our sample r has exceeded g on very few occasions, and since we have used historical averages to arrive at figures for interest rate-growth differential they ended up being at least mildly negative.

6 Conclusions

Knowing the level of debt sustainability in terms of solvency, growth, stability and fairness is crucial for fiscal policy. Excessive government debt can mean not only less prosperity considering the expense of servicing the debt but also bankruptcy of the country. Based on a literature review, an assessment of the fiscal response function was chosen for the debt sustainability study.

The results suggest that for the countries for which debt limits were estimated there is plenty fiscal space and it might not be necessary to balance the budget on account of growing debt, however, the estimates are sensitive to model and parameter choice, assumptions about the interest rate-growth differential and the cluster of countries being studied. When more homogeneous groups are chosen, results reflect expected patterns and models seem to have better statistical properties. Even though samples for Baltic countries and other countries with small economies are much smaller than the whole sample, FRF parameters particularly relevant to the type of application used in this thesis, though mostly not significant at 5% significance level, they are more significant for smaller samples rather than the larger selections of EA12 and EU groups. Therefore, we conclude that heterogeneity among countries masks patterns and grouping more similar countries could lead to more precise estimates.

We hope that this thesis will be useful for further research on this topic. In the future, functional forms other than cubic could be tested, with more explanatory variables included.

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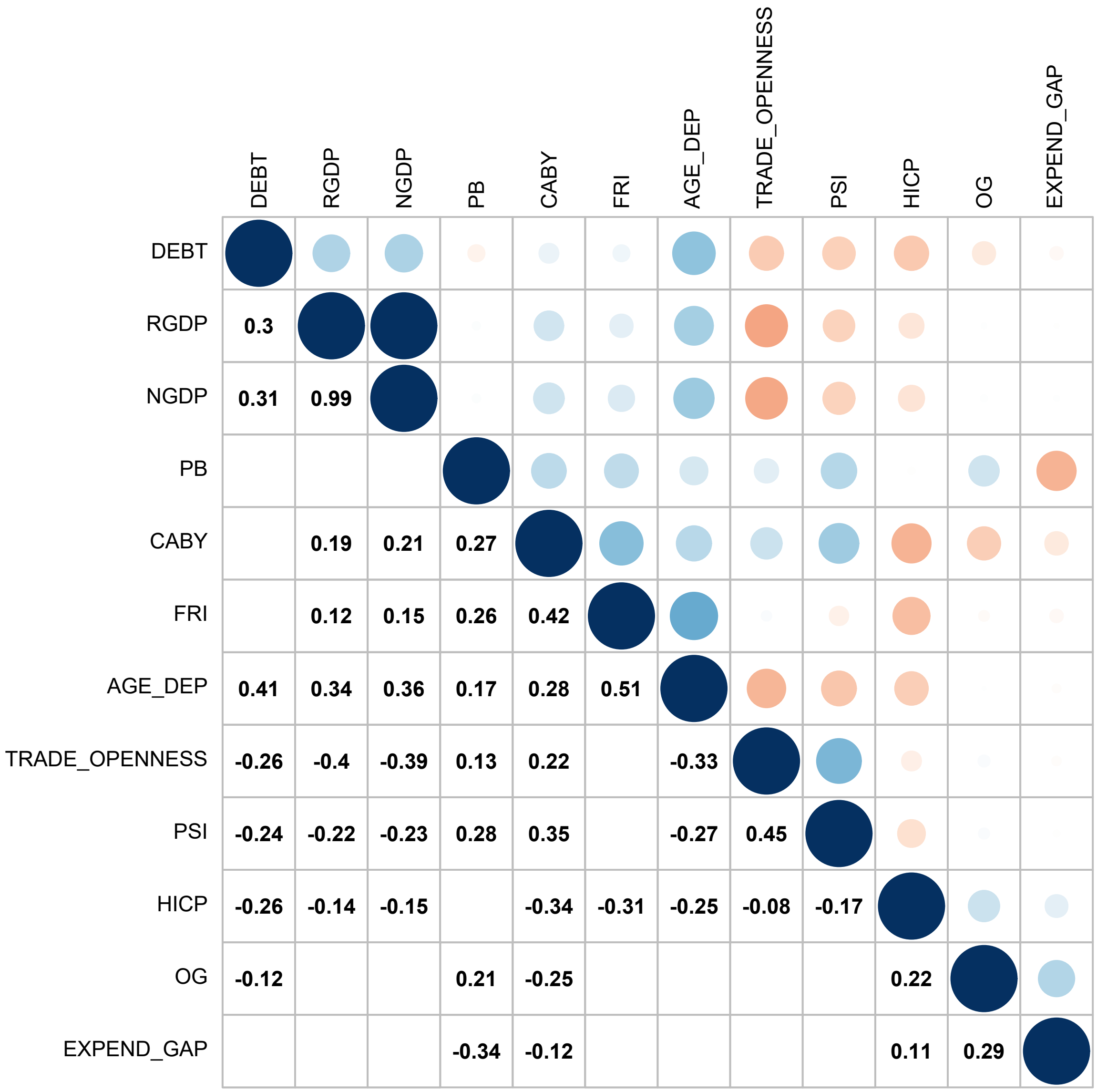
Appendix A Data used in the Thesis

Table 11: Data used in the Thesis

abbreviation	variable	source	comments
PB	primary balance	Eurostat	ratio to GDP
DEBT	general government debt	Eurostat	ratio to GDP
OG	output gap	own calculations	Hodrick-Prescott filter
EXPEND_GAP	government expenditure gap	own calculations	Hodrick-Prescott filter
HICP	harmonised index of consumer prices	Eurostat	annual rate of change
FRI	fiscal rules index	European Commission	
TRADE_OPENNESS	trade openness	own calculations	export and import ratio to GDP
AGE_DEP	age-dependency ratio	Eurostat	
CABY	current account balance	Eurostat	ratio to GDP
PSI	political stability index	World Bank	
-	real interest rate	own calculations	interest paid over debt in previous period
gdp_growth	real GDP growth	Eurostat	
-	nominal GDP growth	Eurostat	

Appendix B Correlation Matrix

A plot of the correlation matrix for the whole dataset of 27 countries.



Appendix C Diagnostic Tests

The results from diagnostic tests for the models used in the thesis are presented in the tables below.

Table 12: Model testing: Baltic countries

test	Model	p-value
Chow test	POLS	0.001
Breusch-Godfrey/Wooldridge test for serial correlation	POLS	0.629
Pesaran CD test for cross-sectional dependence	FE	0.218
Breusch-Godfrey/Wooldridge test for serial correlation	FE	0.339
Durbin-Watson test for serial correlation	FE	0.379
Pesaran CD test for cross-sectional dependence	FE2	0.707
Breusch-Godfrey/Wooldridge test for serial correlation	FE2	0.271
Durbin-Watson test for serial correlation	FE2	0.967
Pesaran CD test for cross-sectional dependence	FEIV	0.192
Breusch-Godfrey/Wooldridge test for serial correlation	FEIV	0.157
Durbin-Watson test for serial correlation	FEIV	0.567

Table 13: Model testing: other small open economies

test	Model	p-value
Chow test	POLS	0.122
Breusch-Godfrey/Wooldridge test for serial correlation	POLS	0.479
Pesaran CD test for cross-sectional dependence	FE	0.032
Breusch-Godfrey/Wooldridge test for serial correlation	FE	0.162
Durbin-Watson test for serial correlation	FE	0.256
Pesaran CD test for cross-sectional dependence	FEIV	0.098
Breusch-Godfrey/Wooldridge test for serial correlation	FEIV	0.218
Durbin-Watson test for serial correlation	FEIV	0.11

Table 14: Model testing: GIIPS

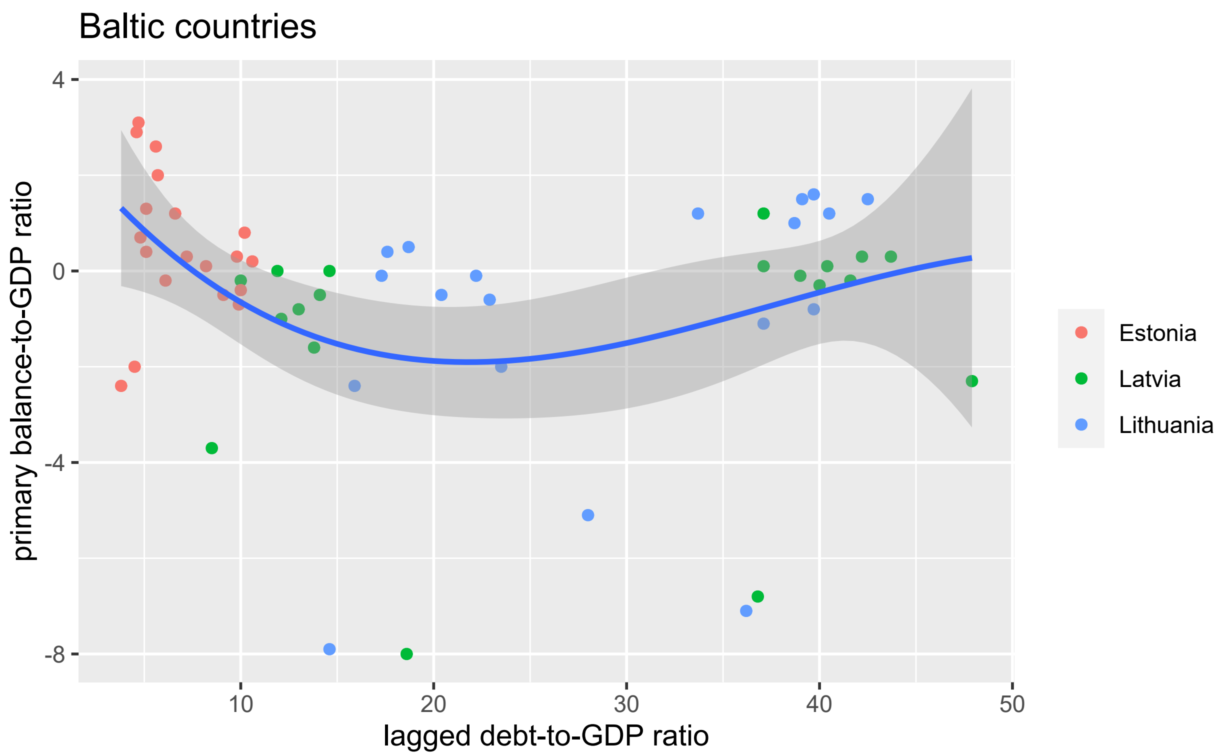
test	Model	p-value
Chow test	POLS	0.001
Breusch-Godfrey/Wooldridge test for serial correlation	POLS	0.809
Pesaran CD test for cross-sectional dependence	FE	0
Breusch-Godfrey/Wooldridge test for serial correlation	FE	0.09
Durbin-Watson test for serial correlation	FE	0.261
Pesaran CD test for cross-sectional dependence	FEIV	0
Breusch-Godfrey/Wooldridge test for serial correlation	FEIV	0.076
Durbin-Watson test for serial correlation	FEIV	0.262

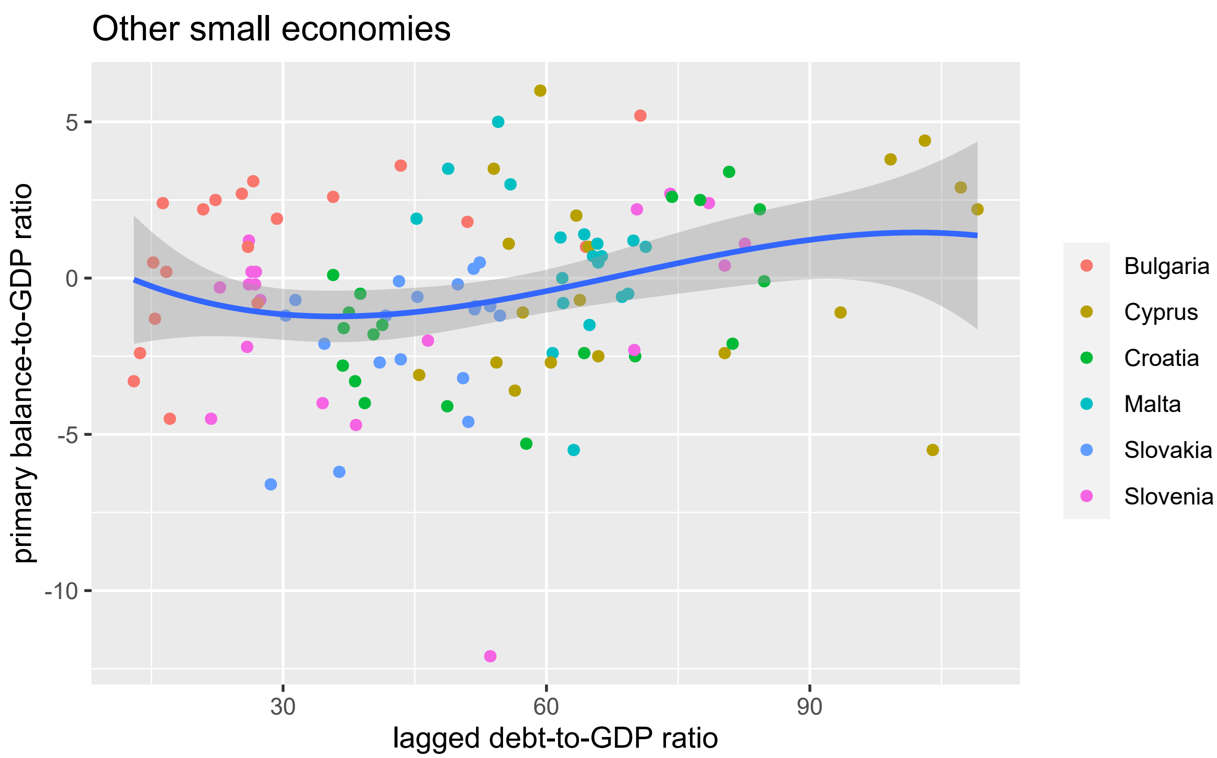
Table 15: Model testing: 12 EA countries

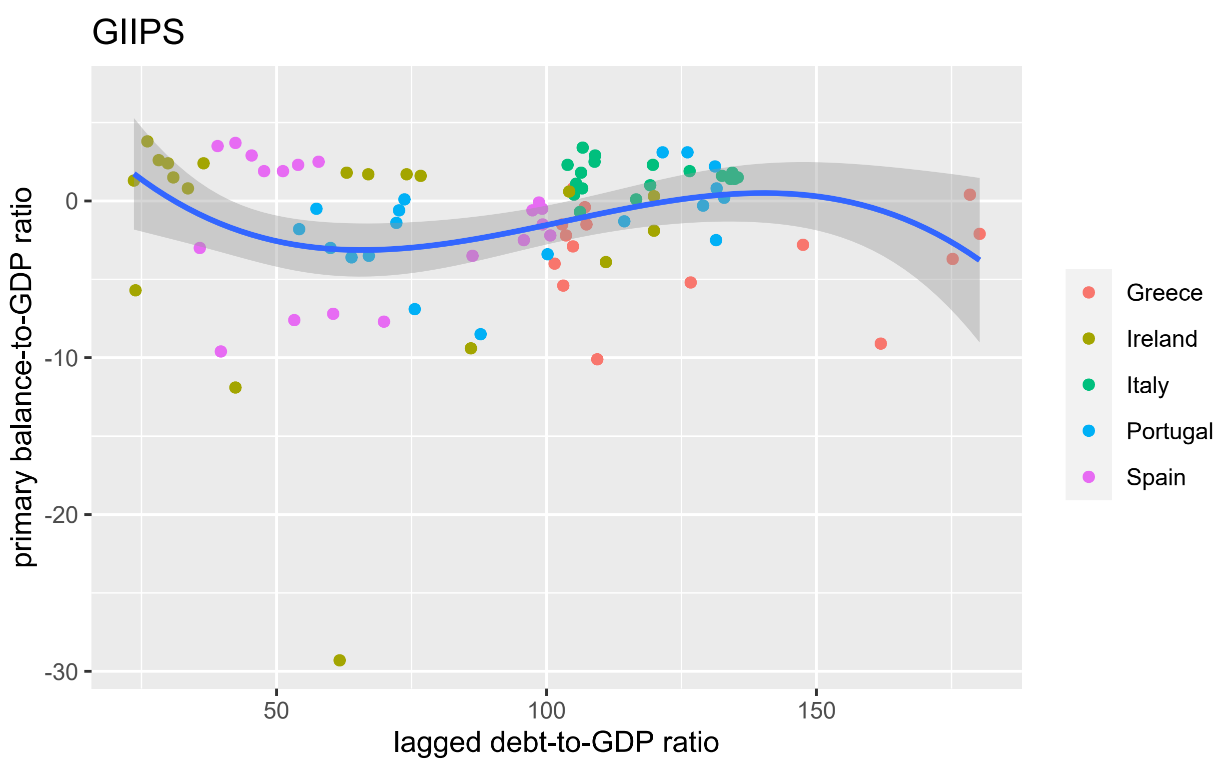
test	Model	p-value
Chow test	POLS	0
Breusch-Godfrey/Wooldridge test for serial correlation	POLS	0.104
Pesaran CD test for cross-sectional dependence	FE	0.847
Breusch-Godfrey/Wooldridge test for serial correlation	FE	0.001
Durbin-Watson test for serial correlation	FE	0
Pesaran CD test for cross-sectional dependence	FEIV	0
Breusch-Godfrey/Wooldridge test for serial correlation	FEIV	0
Durbin-Watson test for serial correlation	FEIV	0.131

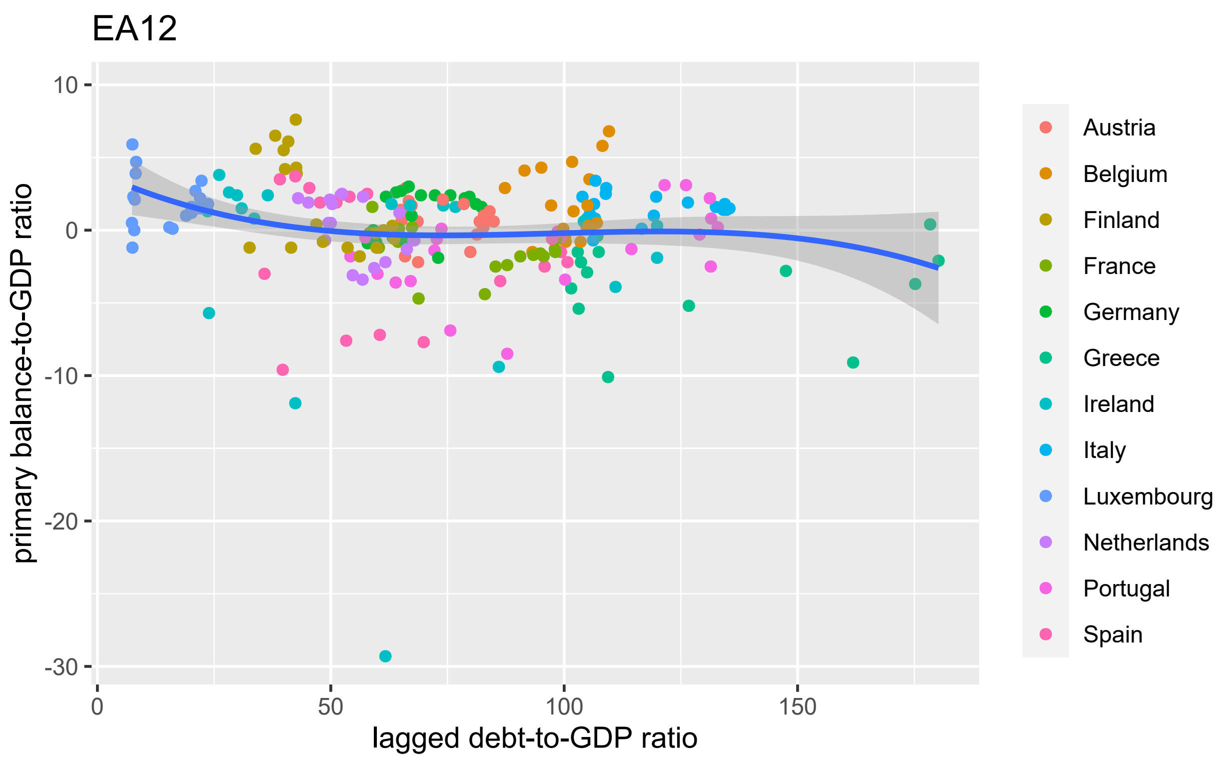
Appendix D Plots

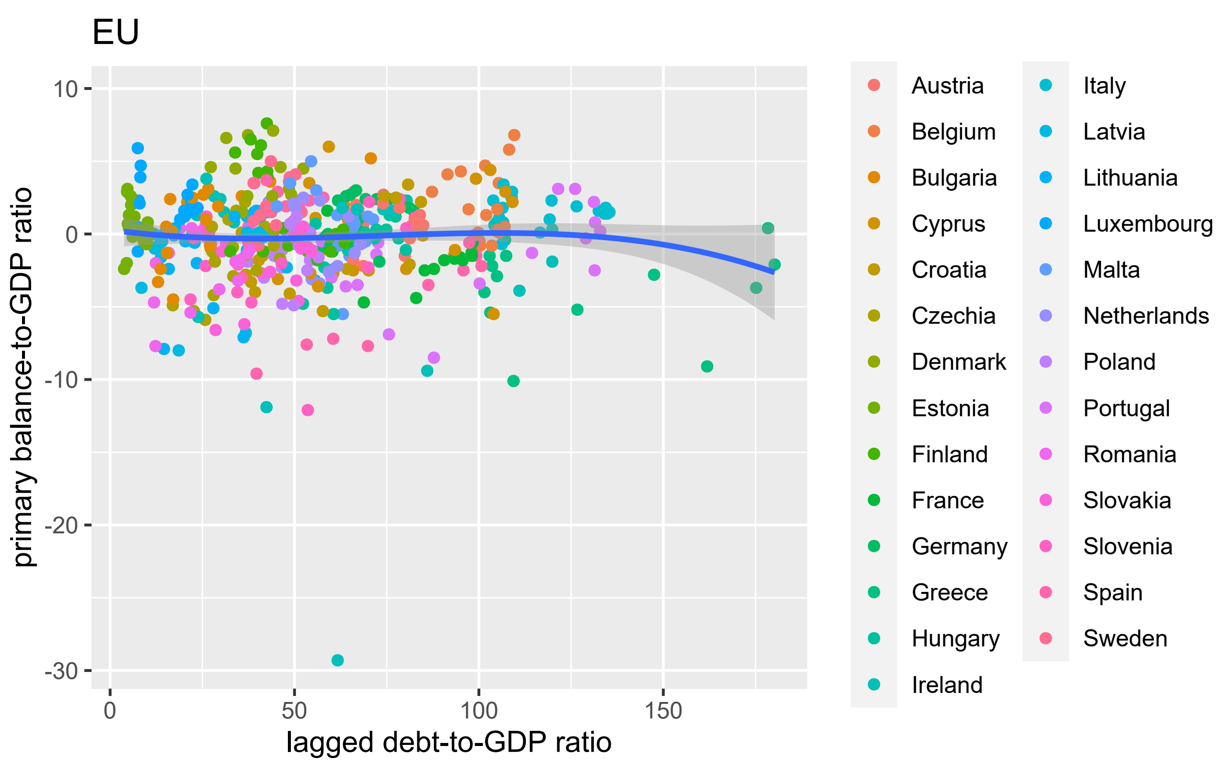
The following plots represent the relationship between primary balance and lagged debt. To help see patterns in the data more easily, smoothing using a linear model is used. The grey zone represents the 95% confidence level interval for predictions from a linear model.




Other small economies
primary balance-to-GDP ratio
lagged debt-to-GDP ratio
5
0
-5
-10
30
60
90
Bulgaria
Cyprus
Croatia
Malta
Slovakia
Slovenia


GIIPS
primary balance-to-GDP ratio
lagged debt-to-GDP ratio
0
-10
-20
-30
50
100
150
Greece
Ireland
Italy
Portugal
Spain


EA12
primary balance-to-GDP ratio
lagged debt-to-GDP ratio
10
0
-10
-20
-30
0
50
100
150
Austria
Belgium
Finland
France
Germany
Greece
Ireland
Italy
Luxembourg
Netherlands
Portugal
Spain


EU
primary balance-to-GDP ratio
lagged debt-to-GDP ratio
10
0
-10
-20
-30
0
50
100
150
Austria
Belgium
Bulgaria
Cyprus
Croatia
Czechia
Denmark
Estonia
Finland
France
Germany
Greece
Hungary
Ireland
Italy
Latvia
Lithuania
Luxembourg
Malta
Netherlands
Poland
Portugal
Romania
Slovakia
Slovenia
Spain
Sweden