

PUBLIC DEBT SUSTAINABILITY IN THE EU DEVELOPED COUNTRIES

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Abstract: *After the global financial crisis in 2008, the topic of public debt sustainability has increased in relevance for the economic literature, causing significant economic structural changes in the affected countries and substantial debates whether the public debt and its projected path are consistent with those of the government's revenues and expenditures. The paper tackles the average reaction coefficients of the primary surplus relative to GDP to variations concerning the debt of the EU most developed economies, using time series data from 2000. The estimated model introduces some control variables that account for the specificities of these countries, namely the domestic credit to private sector and the economic freedom index. In order to estimate the time-varying coefficients, the penalized spline regression model is employed, which is more robust than the OLS estimation.*

Keywords: *public debt, sustainability of public debt, penalized spline regression, developed EU economies.*

Introduction

Ensuring the sustainability of public debt is a challenge for public authorities in all countries of the world. The difficulty of ensuring this economic policy objective will be all the more accentuated, as the economic effects of the current health crisis will be felt more acutely in the coming period. The study of the sustainability of the public debt has a special significance, in the current economic, political and social context, both for the countries of Central and Eastern Europe, as well as for the countries of Western Europe, as the health crisis generated by the COVID-19 virus will have unprecedented economic effects on economies of all countries of the world. The European Commission and the authorities of each EU member country have adopted exceptional economic support measures, which have already generated a significant increase in public debt, but the effectiveness of these

measures can be estimated in the medium and long term. The analysis of public debt sustainability thus becomes a major issue of economic policy.

The main objective of the paper is to analyze the sustainability of the public debt for 14 countries with developed economies of the European Union, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden. The empirical study will be carried out using as statistical variables the primary surplus, the public debt ratio (net), the public debt expenditure, a variable that reflects the business cycle (real GDP fluctuations), the domestic credit to the private sector and the index of economic freedom. These variables were recorded for the period from 2000 to 2019, and the data source is represented by the International Monetary Fund (IMF), the World Bank and the World Governance Indicators (WGI). The statistical method used to evaluate the sustainability of public debt is spline regression; this analysis is carried out to highlight the specific characteristics of the countries in the chosen sample.

The paper is structured in three parts as follows: in the first part, a study of the literature on public debt and the sustainability of public debt will be briefly presented. The second part presents the data and methodology that were used to estimate the sustainability of the public debt. The third part presents the empirical analysis for 14 member countries of the European Union with a developed economy (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Netherlands, Portugal, Spain, Sweden).

Literature review

The economic policy of the EU was guided by the principle of sound public finances with the emergence of the Maastricht Treaty, in this way it was considered to guarantee the stability of the single currency (von Hagen & Wyplosz, 2008). The fiscal policy thus constructed allowed, at the same time, according to Balassone & Franco (2001), sufficient margins for budgetary flexibility in less favorable economic periods. If fiscal policies, left to the discretion of each member state, had the advantage of addressing specific needs, the disadvantage was given by the possibility of excessive use of fiscal instruments, which entailed the increase of deficits and debt, a fact that could have threatened price stability and, in this similarly, the economies of the rest of the euro zone member states would be negatively affected, through two channels (Bergman et al., 2013). The first relevant research on the sustainability of debt policies was conducted by Hamilton & Flavin (1986). These authors analyzed the US government debt and deficit series from 1962-1984 and focused on the stochastic properties of the deficit including interest payments. They concluded that public debt is considered sustainable if it follows a stationary trajectory. After this moment, numerous authors tried to answer the question of whether public debt policies can be considered sustainable.

An important role in many of these sustainability studies is played by the interest rate, to reduce the flow of public debt, recalling that the government's intertemporal budget constraint requires that the present value of public debt asymptotically tends to zero, a point that was emphasized by Wilcox (1989). When addressing public debt sustainability, the focus is mainly on public spending, public revenue, and the role that an economy's Central Bank can play is ignored. This is because it is believed that governments should not rely

on central banks to reduce public debt through money creation, since central banks are independent and are not required to assist governments in implementing policies for sustainable public debt. Authors like Haug (1991), Hakkio & Rush (1991), Trehan & Walsh (1991), Quintos (1995) have studied the deficit sustainability through cointegration tests by analyzing the relationship between primary deficit and debt and found that a stationary deficit including interest payments is sufficient for public debt sustainability if the real interest rate is positive, or the relationship between government revenues and expenditures including interest payments and found that cointegration is only a sufficient condition for deficit sustainability.

Another approach to test public debt sustainability was proposed by Bohn (1998) who investigated how the response of the primary surplus relative to GDP reacts to changes in public debt relative to GDP, arguing that a positive response provides reliable evidence for sustainability debt. This test is very plausible because it has a logical economic intuition: if governments engage in debt today, they must take corrective action in the future by increasing the primary surplus. Otherwise, public debt will not be sustainable. Bohn (1998) proposes a sustainability test that does not require assumptions about interest rates. Ghosh et al. (2013) developed a measure of maximum debt that depends on a country's fiscal response function and the government's ability to change its debt over time. Following this approach, Greiner & Fincke (2016) developed this test from a theoretical point of view and demonstrated that a permanent increase in the debt-to-GDP ratio is not compatible with a sustainable debt policy. A sustainable debt policy requires that the public debt-to-GDP ratio becomes constant and that the transiently increasing debt ratio is compatible with sustainability. Empirical tests conducted demonstrated that most of the analyzed countries reacted positively to higher debt ratios, increasing the principal balance in relation to GDP.

Berti et al. (2016) highlighted that most EU countries have adjusted their fiscal policy positively to the increase in debt levels, using estimated country-specific fiscal reaction functions. When analysing the determinants of the fiscal balance in 27 EU countries and the impact of membership of the Economic and Monetary Union (EMU) on the effectiveness of fiscal rules and fiscal councils, Maltritz & Wüste (2015) found that EMU membership does not have a significant impact on the budget balance. The methodological design follows the approach adopted by Bohn (1998), Greiner & Fincke (2016), Berti et al. (2016) and the empirical study is a follow up on Grosu et al. (2022). Using annual data from 2000 to 2019, we estimated the models using time series for each country in the sample. The estimated model for each country is a semi-parametric model, as the relationship between the primary balance and the debt ratio is characterized by non-linearities (Greiner & Kauermann, 2005). The estimation method is penalized spline regression, which gives more robust estimators than OLS (Hastie & Tibshirani, 1990; Ruppert et al., 2003).

Data and methodology

This paper assesses the responses of governments to debt accumulation in 14 EU countries with developed economies, namely Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain and Sweden. We used data from the year 2000 to 2019. The data sources used are the

International Monetary Fund (IMF), the World Bank and the World Governance Indicators (WGI). We follow the approach proposed by Fincke and Greiner (2012), Greiner and Fincke (2016) and test the response of the primary surplus (% of GDP) to changes in the public debt ratio (% of GDP). To account for countries' specificities, control variables are used, that measure the institutional dimension, through a variable that measures the quality of governance, namely the economic freedom index and the economic dimension, by the share of domestic credit to the private sector (% of GDP).

The economic freedom index is a composite index scored on a scale from 0 to 100, where 100 represents maximum freedom, with ten components grouped into four broad categories: the rule of law (property rights, freedom from corruption); limited government (fiscal freedom, government spending); regulatory efficiency (business freedom, labor freedom, monetary freedom) and open markets (trade freedom, investment freedom and financial freedom). Domestic credit to the private sector refers to financial resources provided to the private sector by financial corporations, such as through loans, purchases of non-equity securities and trade credits and other accounts receivable, which establish a demand for repayment.

The general form of the econometric models estimated in the paper is similar to that adopted by Bohn (1998), Greiner & Fincke (2016), Berti et al. (2016).

For the time series estimations, we used a semi-parametric model as shown below:

$$PB_t = \beta_0 + f(Debt_{t-1}) + \beta_1 Expend_t + \beta_2 GDP_t + \beta_3 Z_t + \varepsilon_t,$$

where PB_t represents the primary surplus (% of GDP), and $Debt_{t-1}$ means the debt rate lagged by a period, since the budget plans are made a year in advance. The other variables, $Expend_t$ and GDP_t , are the variables derived from public spending and real GDP fluctuations, the latter being a business cycle variable in the model. These were obtained by subtracting the long-term trend of the series, obtained by applying the Hodrick-Prescott filter. The Z_t variables are the control variables that reflect the specificities of the economies of the countries under consideration (domestic credit to the private sector and the index of economic freedom). $f(Debt_{t-1})$ is a smoothing function (unknown, but smooth, that are to be estimated from the empirical data) using the lagged debt rate. The coefficients β_i , $i = 1, 2, 3$ are the coefficients associated with the variables $Expend_t$, GDP_t , and Z_t , respectively. The term ε is the error term.

Penalized spline regression is used as an estimation method, since it provides more robust estimators than OLS (Hastie & Tibshirani, 1990; Wood, 2000; Ruppert et al., 2003). The data source is the International Monetary Fund (IMF), the World Bank and the World Governance Indicators (WGI).

Empirical findings

The empirical study carried out in this paper concerns the sustainability of public debt in the 14 developed economies of the EU. Before presenting the results, we provide a brief description of the analyzed variables, followed by the time series estimates.

Data summary

The data used for the empirical study consists of annual data from 2000 to 2019 for the 14 developed countries in the EU. The missing values were imputed using simple imputation methods. The visual representation of the variables' dynamics is shown in the Figures 1 to 6.

The primary surplus

The primary surplus, calculated as the difference between general government revenues and general government expenditures, excluding interest payments (as % of GDP), for the countries in the sample, in the period 2000-2019, is represented in Figure 1.

Figure 1. Primary surplus (% of GDP) dynamics for the 14 countries, from 2000 to 2019

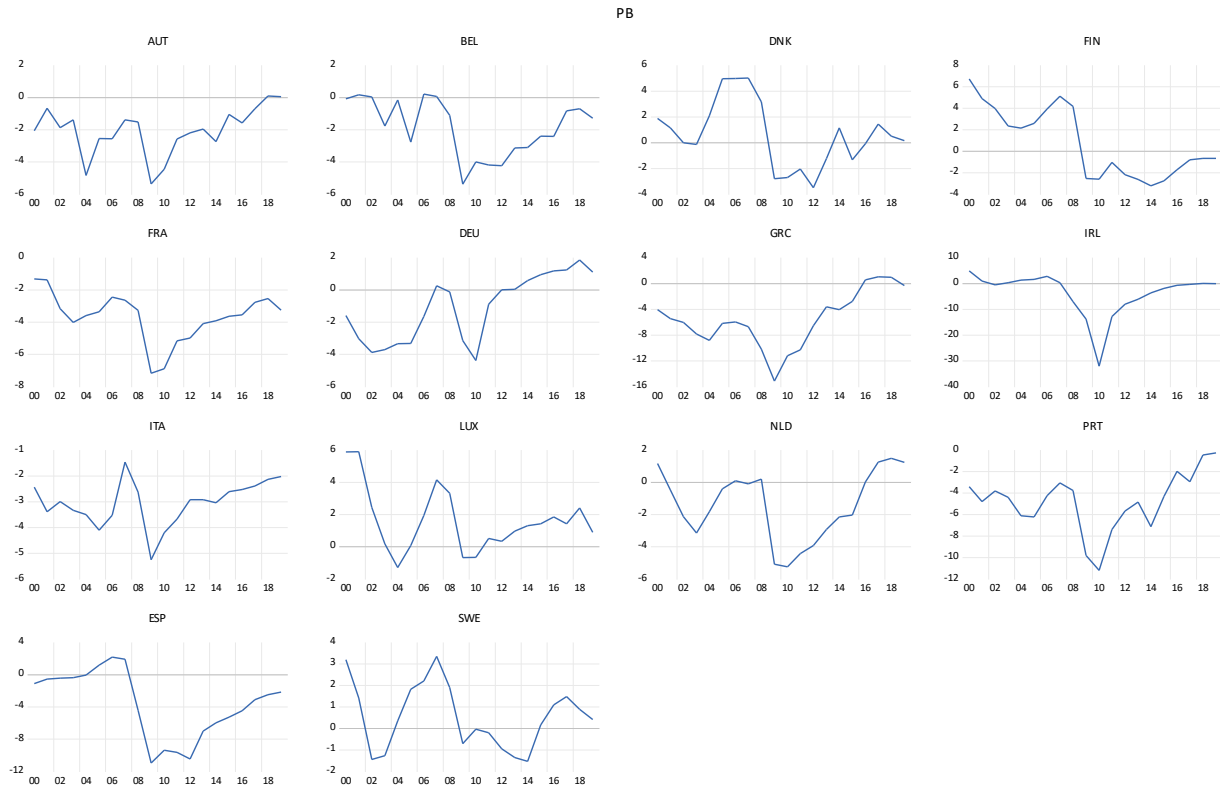


Figure 1 shows that most countries recorded primary deficits for the entire period between 2000 and 2019, with only a few exceptions, notably Belgium, Denmark, Finland and Spain, for the period before the financial crisis. The rest of the countries recorded deficits, with significant differences in their size and trend. Some countries have been able to better control government spending and revenue, significantly improving their primary surplus, such as Austria, France, Germany, Greece, the Netherlands, Portugal, while others, such as Denmark, Finland, Spain, Sweden, underperformed with moderate improvements in their primary surplus. The case of Luxembourg is special, as the country deepened its primary deficit, from 6% in 2000 to more than -1.5% around 2004.

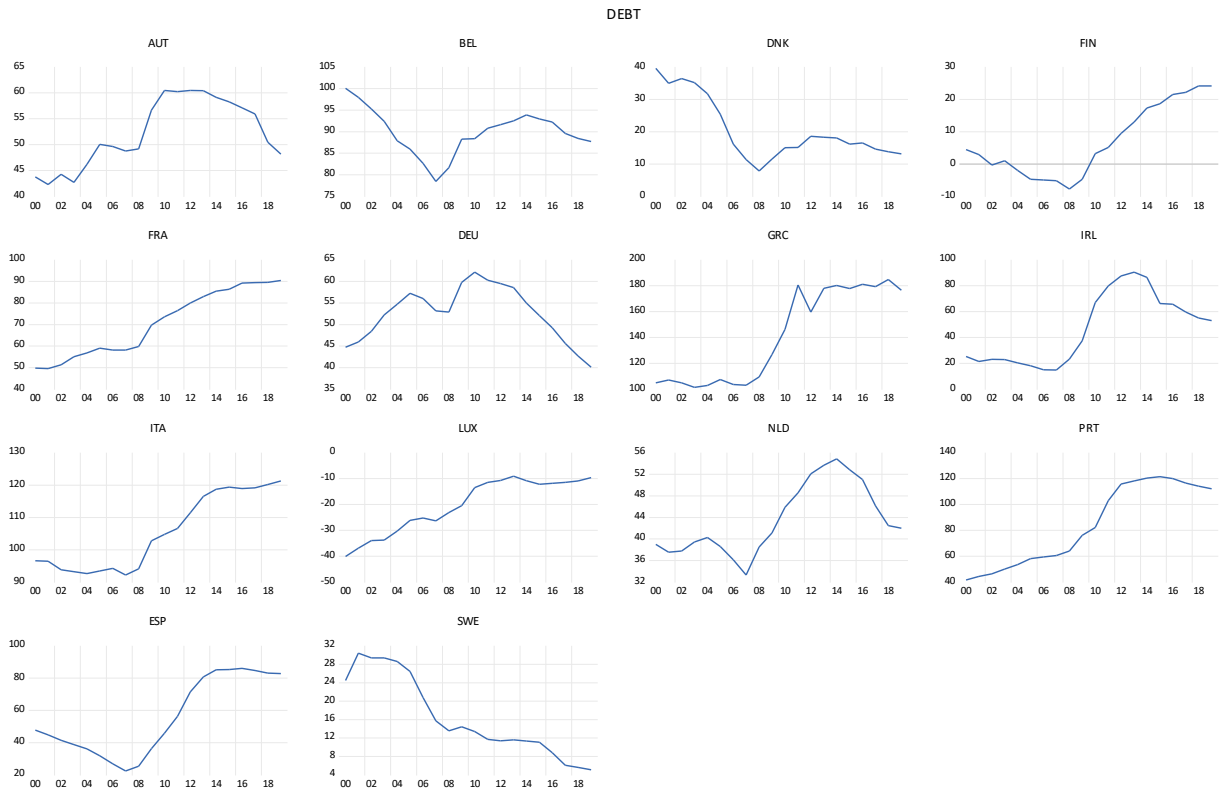
An important contribution to the favorable evolution of the economic situation of these countries can be attributed to the application of fiscal governance in all EU countries,

after the adoption of the Treaty on the establishment, coordination and governance of the Economic and Monetary Union.

Public debt rate

The graph for the public debt ratio for the 14 European countries, from 2000 to 2019, is represented in Figure 2.

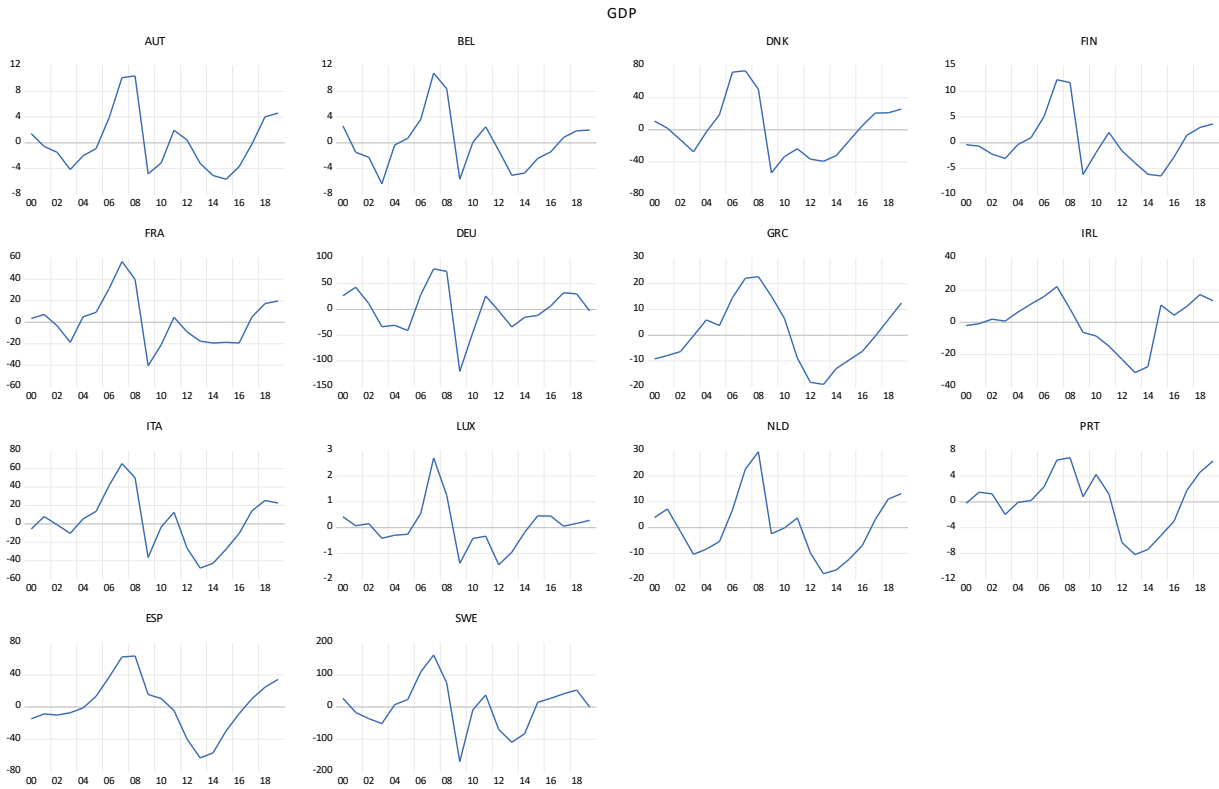
Figure 2. Public debt ratio dynamics for the 14 countries, from 2000 to 2019



Business cycle

The visual representation for the business cycle, which represents the changes in real GDP for the 14 countries, from 2000 to 2019, is shown below, in Figure 3.

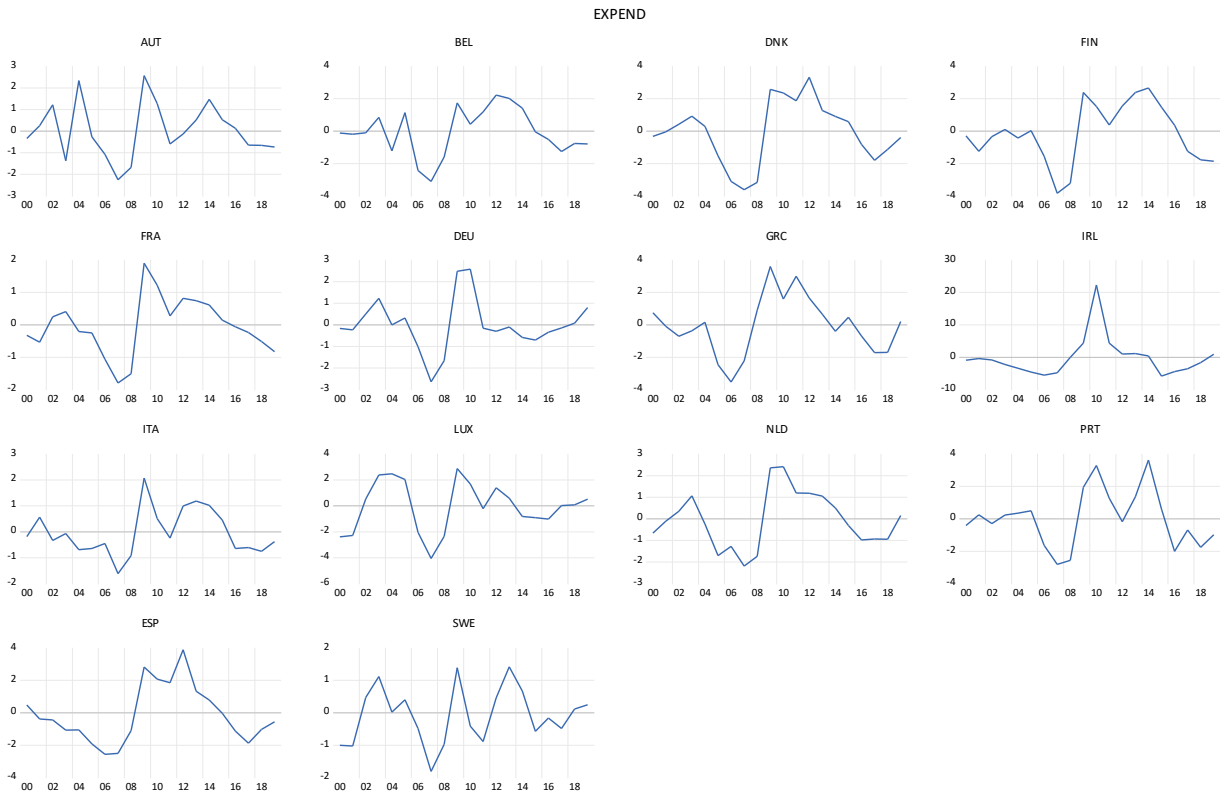
Figure 3. Business cycle dynamics for the 14 countries, from 2000 to 2019



Public debt expenditures

The graph for the variable representing public debt expenditure fluctuations around their trend (% of GDP) for the 14 countries, from 2000 to 2019, is represented below.

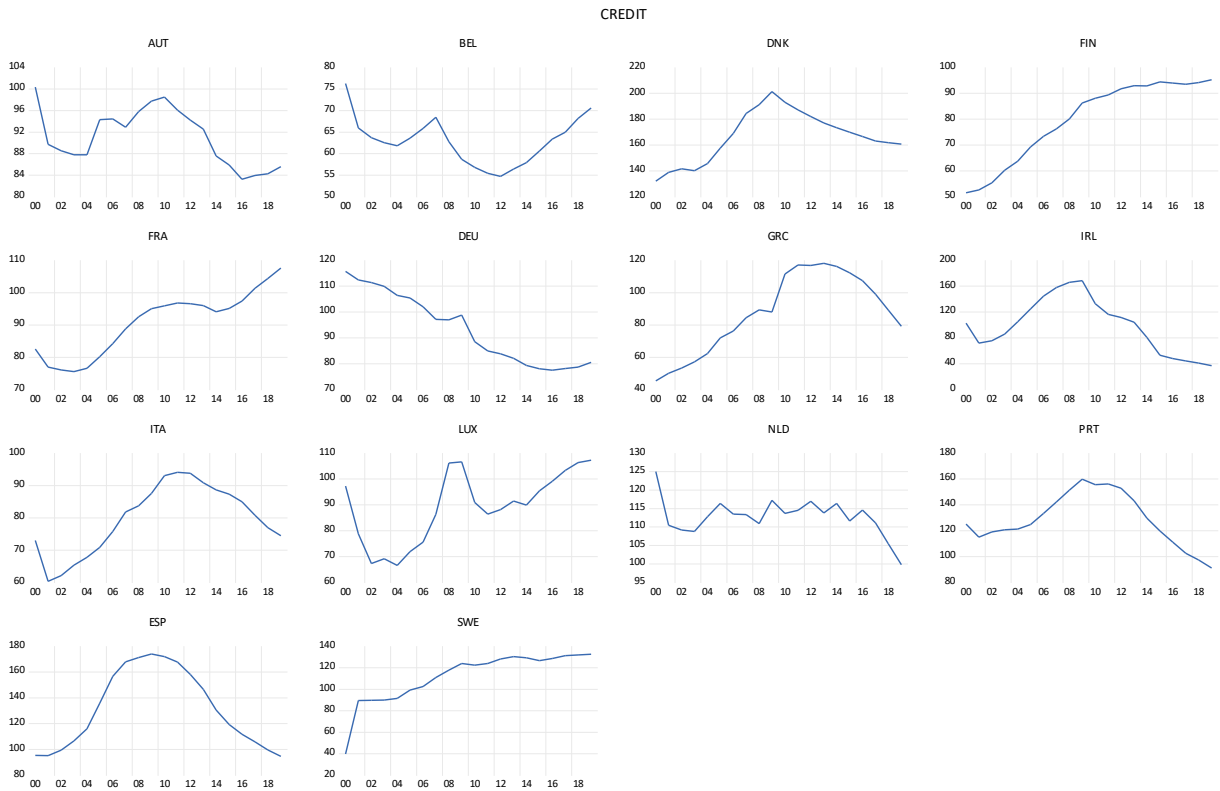
Figure 4. Public debt expenditure dynamics (% of GDP) for the 14 countries, from 2000 to 2019



Domestic credit of the private sector

The visual representation of the dynamics of the domestic credit for the private sector (% of GDP) for the 14 countries, from 2000 to 2019, is represented in Figure 5.

Figure 5. Domestic credit for the private sector dynamics (% of GDP) for the 14 countries, from 2000 to 2019

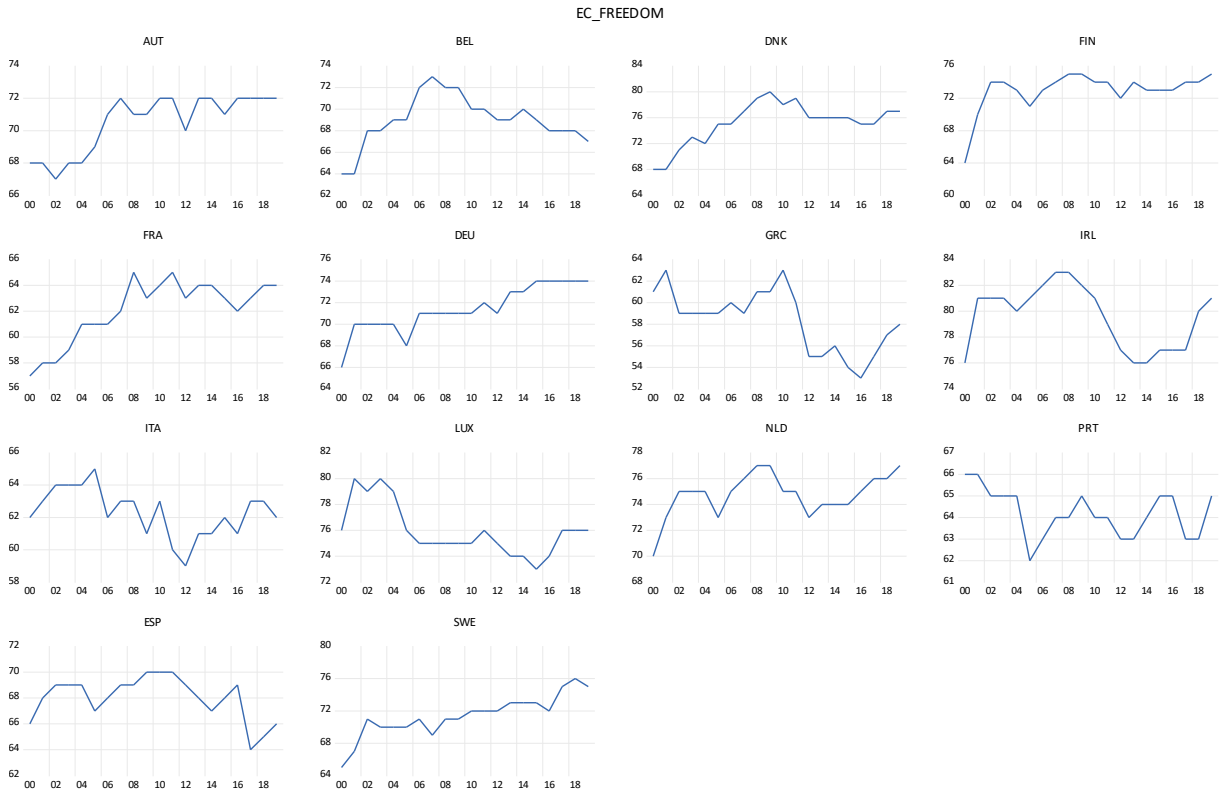


Analyzing the graph above, we can see that at the beginning of the 2000s, all countries, with developed, stable economies, register a very high level of domestic credit for the private sector. Only Ireland, Greece and Sweden reached the lowest value, of 40%. Although in all countries the values have increased over the period under review, there are still large differences between countries in terms of the pace of growth and the level to which it has reached. The highest value of 200% was achieved by Denmark. Moreover, we note that the trend has been reversed for a few countries, notably Germany, which has seen a sharp decline.

Index of economic freedom

The graph for the dynamics of economic freedom index, for the countries in the sample, are presented in Figure 6.

Figure 6. Index of economic freedom dynamics for the 14 countries, from 2000 to 2019



All countries improved their economic freedom during this period, reaching an average score of 70 points in 2019. Among these countries, Finland has the highest index, over 72 points for the entire period, while Italy has the lowest index below 53 points during this period. With small fluctuations, all countries recorded an upward trend in the index of economic freedom.

Estimating spline regression

The results of estimating the econometric models for the European countries in our sample, using as control variables the domestic credit for the private sector (% of GDP) and the index of economic freedom are presented in Tables 1 and 2. The models presented in these tables were chosen in as a function of the smallest generalized cross-validation (GCV) statistic and the largest adjusted multiple determination ratio (Adj. R2) value. The results for which the coefficient of the smooth function is statistically significant are presented. Denmark is the only country for which the model containing the economic freedom index is not statistically significant.

Estimated regression coefficients

The estimated equations are presented as follows, in Tables 1 and 2.
Domestic credit for the private sector

Table 1 : Coefficients for models using domestic credit for the private sector (% of GDP) as a control variable (dependent variable: primary surplus as % of GDP)

Variables	AUT	BEL	DNK	FIN	FRA	DEU	GRC	IRL	ITA	LUX	NLD	PRT	ESP	SWE
Constant	1.219 (6.315)	10.83 5 (7.006)	- 20.63 5 (6.247)	14.38 7 *** (1.585)	- 15.79 1 *** (3.581)	- 33.459 ** (15.042)	-6.003 (8.124)	2.536 (7.348)	- 12.43 4 *** (3.867)	- 1.039 (1.459)	-5.845 (4.826)	- 11.034 (10.832)	- 35.254 * (16.512)	25.115 *** (5.958)
PB_{t-1}	0.088 (0.168)	- 0.347 (0.186)	0.100 (0.134)	0.030 (0.076)	0.543 (0.095)	0.080 (0.144)	0.190 (0.159)	-0.112 (0.129)	0.295 (0.157)	0.154 (0.088)	0.111 (0.115)	-0.111 (0.108)	0.007 (0.194)	0.561 *** (0.123)
$Debt_{t-1}$	0.014 (0.034)	- 0.049 (0.046)	0.156 *** (0.045)	-0.109 (0.142)	0.119 *** (0.271)	0.041 (0.044)	-0.031 (0.026)	-0.301 (0.227)	0.042 ** (0.016)	0.016 (0.035)	-0.040 (0.059)	-0.018 (0.045)	0.320 ** (0.103)	0.003 (0.029)
$Expend$	-0.702 *** (0.185)	- 0.670 ** (0.186)	-0.991 ** (0.337)	0.214 (0.300)	-0.696 ** (0.305)	-0.999 *** (0.231)	-1.137 *** (0.205)	-1.053 *** (0.093)	-0.445 (0.300)	- 0.791 *** (0.175)	-1.047 *** (0.188)	-1.109 *** (0.108)	-0.496 (0.348)	0.146 (0.310)
GDP	0.024 (0.058)	0.080 (0.048)	0.006 (0.017)	0.343 *** (0.091)	0.011 (0.011)	0.002 (0.006)	-0.114 * (0.059)	-0.040 (0.050)	0.009 (0.010)	- 0.203 (0.360)	0.014 (0.027)	0.075 (0.096)	0.090 * (0.038)	0.008 ** (0.003)
$Credit$	-0.072 (0.051)	- 0.021 (0.091)	0.088 *** (0.028)	-0.185 *** (0.021)	-0.030 * (0.024)	0.268 * (0.127)	0.037 (0.059)	-0.048 (0.043)	0.019 (0.017)	0.024 (0.018)	0.033 (0.051)	0.050 (0.060)	0.072 (0.090)	-0.207 *** (0.048)
sm_t	F stat. 0.057 *	F stat. 0.004 ***	F stat. 0.009 ***	F stat. 0.000 9 ***	F stat. 0.000 04 ***	F stat. 0.049 **	F stat. 0.017 **	F stat. 0.007 ***	F stat. 0.040 **	F stat. 0.044 **	F stat. 0.004 ***	F stat. 0.020 **	F stat. 0.007 ***	F stat. 0.003 ***

Standard error in brackets
 ***p<0.01; **p<0.05; *p<0.1.

The coefficients for net debt ratios are statistically significant for four countries: Denmark, France, Italy and Spain. For all these countries, the coefficients are positive, indicating that the primary surplus increases with the increase in the debt-to-GDP ratio. These results allow us to support the sustainability of the public debt for these countries in the analyzed period. Moreover, if we look at the deviation $f(.)$ from the average coefficient of the $Debt_{t-1}$ variable (Figure 7), where the graph of the smooth function is represented, we notice that the reaction of the primary surplus to the changes in the debt ratio for Denmark increased for the whole period. For France and Italy, even if the overall trend is decreasing, it has remained positive for the entire period. For Spain, the time trajectory of the term of the smooth function shows an increasing pattern at the beginning of the period and then starts to decrease again. The decreasing path of the coefficient of this function over time indicates that the government attached less importance to the stabilization of the public debt.

Considering the coefficients for government spending, we notice that we have significantly negative coefficients for almost all countries, indicating that the primary surplus is lower in periods of higher public spending.

If we analyze the business cycle variable, we notice that for Finland, Spain and Sweden the coefficient is positive and significant at 0.1, which proves that periods of economic boom and recession respectively cause a positive and negative effect on the primary surplus. In contrast, for Greece, the coefficient of the business cycle variable is significant and negative.

The coefficients for PBT-1 (primary surplus for the previous year) are statistically significant and positive, at 0.1, for 3 countries: France, Italy and Sweden.

Index of economic freedom

Table 2: Coefficients for models using the index of economic freedom as a control variable (dependent variable: primary surplus as % of GDP)

Variables	AUT	BEL	FIN	FRA	DEU	GRC	IRL	ITA	LUX	NLD	PRT	ESP	SWE
<i>Constant</i>	14.886 (14.202)	-0.004 *** (0.001)	27.07 1 ** (9.211)	- 38.47 5 *** (5.085)	25.051 ** (10.149)	17.844 (11.205)	- 20.405 (38.801)	-0.016 ** (0.006)	0.234 (8.706)	15.187 (17.691)	7.938 (16.421)	- 41.828 ** (11.840)	19.684 ** (7.592)
<i>PBT_{t-1}</i>	0.166 (0.152)	0.174 (0.105)	0.217 (0.136)	0.263 (0.147)	0.126 (0.120)	0.020 (0.140)	0.135 (0.093)	0.253 * (0.135)	0.188 * (0.090)	0.176 (0.111)	-0.037 (0.103)	-0.012 (0.180)	0.198 (0.117)
<i>Debt_{t-1}</i>	0.130 (0.334)	0.037 *** (0.010)	0.006 (0.029)	0.119 ** (0.044)	-0.027 (0.017)	-0.053 * (0.024)	-0.044 (0.076)	0.034 ** (0.012)	0.001 (0.035)	-0.036 (0.048)	-0.040 (0.042)	0.299 *** (0.066)	-0.145 * (0.063)
<i>Expend</i>	-0.775 *** (0.183)	-0.989 *** (0.163)	- 1.534 *** (0.455)	-0.918 *** (0.208)	-0.950 *** (0.194)	-1.228 *** (0.186)	-1.151 *** (0.082)	-0.573 ** (0.255)	-0.891 *** (0.176)	-1.001 *** (0.160)	-1.169 *** (0.105)	-0.447 (0.284)	-0.122 (0.332)
<i>GDP</i>	0.017 (0.058)	-0.021 (0.056)	- 0.141 * (0.141)	-0.018 * (0.008)	0.001 (0.005)	-0.079 (0.056)	-0.062 (0.054)	0.006 (0.008)	-0.391 (0.349)	0.016 (0.023)	0.032 (0.085)	0.093 ** (0.033)	0.008 (0.004)
<i>Ec_freedom</i>	-0.303 (0.203)	-0.119 *** (0.025)	- 0.357 *** (0.127)	0.386 *** (0.050)	-0.326 ** (0.131)	-0.342 * (0.162)	0.157 (0.058)	-0.149 *** (0.043)	-0.001 (0.115)	-0.210 (0.198)	-0.177 (0.211)	0.242 (0.148)	-0.271 ** (0.102)
<i>sm_t</i>	F stat. 0.011 **	F stat. 0.005 ***	F stat. 0.021 **	F stat. 3.88 e-16 ***	F stat. 0.0002 ***	F stat. 0.007 ***	F stat. 0.013 **	F stat. 0.033 **	F stat. 0.057 *	F stat. 0.003 ***	F stat. 0.001 ***	F stat. 0.0009 ***	F stat. 0.003 ***

Standard error in brackets
***p<0.01; **p<0.05; *p<0.1.

Analyzing the coefficients of the net debt ratio, we observe that for Belgium, France, Italy and Spain the coefficients are significantly positive, indicating the sustainability of the public debt, while for Greece and Sweden the coefficients are significant and negative, which suggests that these countries follow an unsustainable debt policy. The graphs of the smooth term for Belgium and Italy (Figure 11 and Figure 14) are centered around the average value of the reaction coefficient, showing a weak sustainability policy. While for France and Spain it shows that, even if the overall trend is decreasing, the response of the primary balance has remained positive for many years of the period considered in our study. The graphs of the smooth term for Greece and Sweden have a

slight upward trend, which indicates that the governments of these countries are concerned with stabilizing the public debt. Considering the estimation results for government spending and business cycle variables, we obtained similar results for almost all countries. The significantly negative coefficients for government spending are in line with our expectations, suggesting public debt sustainability.

Visual representation of the smooth function

In the following, the graphs obtained for the countries for which the net debt ratio coefficients are statistically significant, for the two models are presented in Figures 7 to 16.

Domestic credit for the private sector

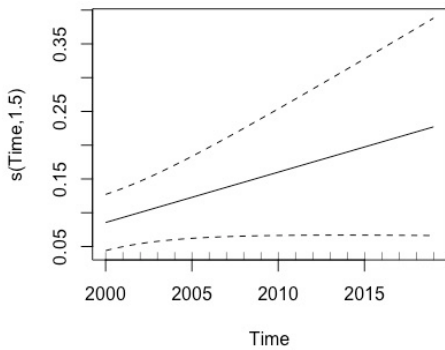


Figure 7. The smooth function for the model with the control variable domestic credit for the private sector (% of GDP), for Denmark

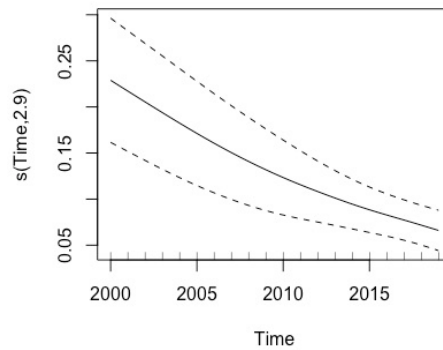


Figure 8. The smooth function for the model with the control variable domestic credit for the private sector (% of GDP), for France

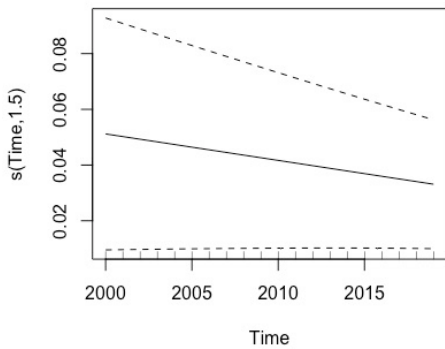


Figure 9. The smooth function for the model with the control variable domestic credit for the private sector (% of GDP), for Italy

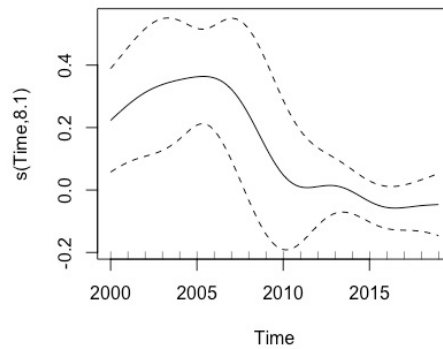


Figure 10. The smooth function for the model with the control variable domestic credit for the private sector (% of GDP), for Spain

Index of economic freedom

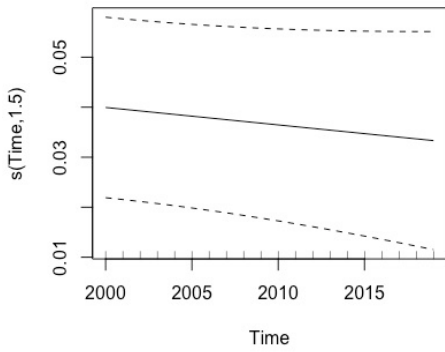


Figure 11. The smooth function for the model with the control variable index of economic freedom, for Belgium

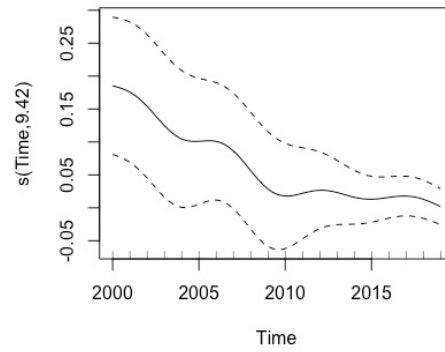


Figure 12. The smooth function for the model with the control variable index of economic freedom, for France

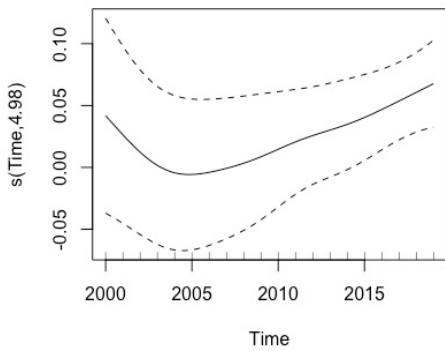


Figure 13. The smooth function for the model with the control variable index of economic freedom, for Greece

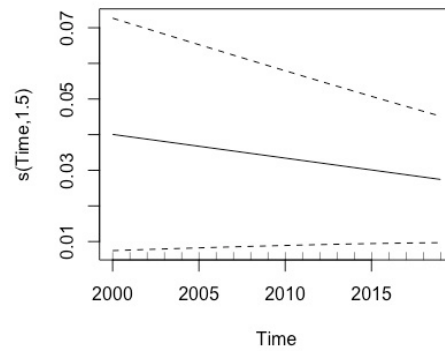


Figure 14. The smooth function for the model with the control variable index of economic freedom, for Italy

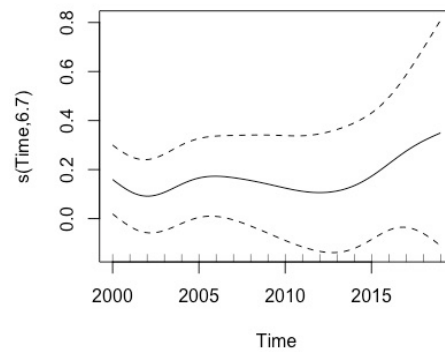
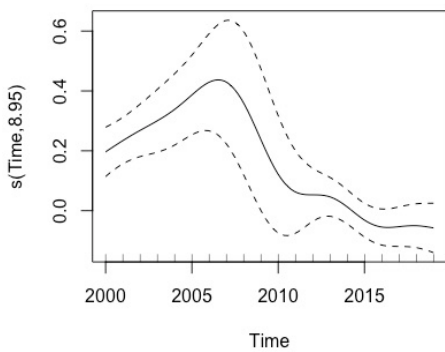


Figure 15. The smooth function for the model with the control variable index of economic freedom, for Spain

Figure 16. The smooth function for the model with the control variable index of economic freedom, for Sweden

Validation of the estimated models

The criteria used to validate the models are the criteria based on the adjusted multiple determination ratio and the cross-validation criterion. Cross-validation evaluates the fit of the model to a given λ in a very similar manner to RSS, but removes the point y_i and evaluates how well the fit of this removed point predicts. In other words, it tries to minimize the RSS while ignoring the closest point, hence it is often referred to as the "drop-out" strategy. This is formally defined as

$$CV(\lambda) = \sum_{i=1}^n \{y_i - \hat{f}_{-1}(x_i; \lambda)\}^2$$

where $\hat{f}_{-1}(x_i; \lambda)$ refers to fitting the spline function without the point (x_i, y_i) . This allows to find λ for a given spline basis that minimizes this value while allowing for the prediction of new points and avoiding the danger of over-fitting.

The best results that are obtained after such an estimation are those that have the value of the adjusted determination ratio as high as possible and the value of the cross-validation criterion as low as possible.

The results of the model validation criteria obtained for the fourteen countries in the period 2000-2019 are presented in Tables 3 and 4.

Domestic credit for the private sector

Table 3: The results for Adj. R2 and GCV tests, for the model with the control variable domestic credit for the private sector (% of GDP)

Tests	AUT	BEL	DNK	FIN	FRA	DEU	GRC	IRL	ITA	LUX	NLD	PRT	ESP	SWE
Adj. R ²	0.843	0.980	0.901	0.996	0.965	0.965	0.946	0.987	0.618	0.928	0.945	0.977	0.986	0.865
GCV	0.589	0.199	1.002	0.130	0.135	0.293	1.787	2.515	0.440	0.465	0.473	0.512	0.755	0.474

Index of economic freedom

Table 4: The results for Adj. R2 and GCV tests, for the model with the control variable index of economic freedom

Tests	AUT	BEL	FIN	FRA	DEU	GRC	IRL	ITA	LUX	NLD	PRT	ESP	SWE
Adj. R ²	0.833	0.863	0.936	0.997	0.95	0.965	0.971	0.655	0.924	0.940	0.971	0.991	0.954
GCV	0.621	0.595	1.021	0.024	0.333	1.359	3.736	0.369	0.503	0.490	0.573	0.568	0.270

Comparing the empirical results generated by the econometric models estimated for the 14 countries using the statistical variables that highlight the specific characteristics of these countries (domestic credit for the private sector and the index of economic freedom), we can conclude that the model that includes the domestic credit for the private sector, having the lowest GCV values and the highest adjusted R2, best reproduces the data generation process and is the best for most of the countries in our sample. This result shows that this model is more relevant to the analysis of public debt sustainability than the one with economic freedom and could represent a more useful tool in the process of economic policy making.

Conclusions

The paper aims at analyzing the sustainability of the public debt for developed European countries, a highly debated topic in the specialized literature due to the rapid accumulation of public debt in many European countries. Debt sustainability concerns are not very high for developed European countries compared to Eastern European countries, which underwent major institutional and structural changes in the 1990s and are still characterized by macroeconomic uncertainty and vulnerability, even though they have reached in the early 2000s, the status of the market-based economy. These concerns were amplified by the financial crisis that hit the world in 2008, followed by a sovereign debt crisis in some countries.

In the analysis of the sustainability of the public debt, we followed the approach proposed by Fincke and Greiner (2012), Greiner and Fincke (2016), which is appropriate in our case considering the characteristics mentioned above. In addition, in the econometric model, in terms of specification, we included control variables that measure both economic and institutional dimensions: the domestic credit for the private sector and the index of economic freedom.

The empirical results show that the domestic credit for the private sector significantly influenced the primary surplus in four countries: Denmark, Finland, Germany, and Sweden. For Finland and Sweden, the coefficients are significantly negative and indicate that for these countries, the ratio of the primary surplus worsens in the periods with the increase of the domestic credit for the private sector. The findings can be explained by the reduction in domestic credit available to the government, which may increase the public debt burden. At the same time, for Denmark and Germany, the coefficients are statistically significant and positive, presenting opposite situations to those presented previously. For the rest of the countries, the coefficients are not statistically significant, and we cannot conclude that the level of domestic credit for the private sector has a positive or negative impact on public debt sustainability.

As for the economic freedom index, the empirical results highlighted the fact that for seven European countries the coefficients for the economic freedom index are statistically significant: Belgium, Finland, France, Germany, Greece, Italy and Sweden. In France, the coefficient is positive, showing that the improvement in the index of economic freedom contributed positively to the primary surplus. For the rest of the countries for which the model generated significant results, the coefficients are negative but close to zero, except for Finland, Germany and Greece. These differences can be explained by variations and fluctuations in the levels of the primary surplus and the index of economic freedom. Even if a country has significantly improved its institutions, potential limitations on primary surplus adjustment in response to rising public debt-to-GDP ratios can moderate the benefits of stronger institutions. Also, the moderate improvement in the index of economic freedom, even if they correspond to already high levels, may not have any impact on public debt management.

Regarding the sustainability of public debt, the empirical results prove that only a few countries (Belgium, Denmark, France, Ireland, Italy, and Spain) pursued, to a certain extent, sustainable public debt policies during the analyzed period. Moreover, our models prove that only two countries (Greece and Sweden) implemented an unsustainable public debt policy. For the other countries in our sample, the statistically insignificant results suggest that the hypothesis of an unsustainable public debt policy cannot be rejected.

Despite the limitations of our research, especially the small data series, the results are in line with the literature for these countries and can be used as recommendations for a more prudent fiscal policy in the years to come.

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