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How to Assess Public Debt Sustainability: Empirical Evidence for the Advanced European Countries

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ABSTRACT

In the context of a society with limited resources, borrowing seems to be a desirable method that allows governments to finance the required expenditures. But government borrowing is accepted as long as it is consistent with a sound fiscal policy. Since 1923, when the concept of sound finance was brought into discussion for the first time, by J. M. Keynes, many economists have tried to investigate the issue of public debt sustainability. The hereby paper is designed to be an introductory guide in the theory and practice of fiscal sustainability. In this sense, I tried to make a compelling analysis of the evolution of the public debt among the advanced European economies. I have chosen these countries considering that European Union fiscal sustainability is still a much debated and controversial topic and that unsound fiscal policies of individual members could have adverse effects and harm other members' economies. For the purpose of this study I used annual data, spanned mostly on 1970-2012. The variables for each country have been analyzed through various methods of investigation: unit-root tests, cointegration tests and fiscal reaction function tests. The aim of this paper is therefore to investigate the evolution of the public debt and to establish how governments react to this evolution.

Keywords: Fiscal policy, public debt, solvability, intertemporal budgetary constraint, non-Ponzi game condition, fiscal rule

JEL codes: E62

1. Introduction

The concept of public debt sustainability has been thoroughly studied in the last decades, considering the severe consequences that the misuse of public borrowings could generate. The researchers tried to assess how high can public debt rise without compromising fiscal solvency.

It is known that running unsustainable fiscal policies could worsen the macroeconomic conditions and make economies more vulnerable to exogenous shocks. An unsustainable fiscal policy could harm the welfare state through large fiscal deficits and excessive public debt stocks, generating an inefficient allocation of resources, an excessive public debt stock that could affect future generations, and an increase in the inflation rate and its volatility. These harmful consequences are not just hypothetical. They are confirmed by the fact that many developed economies have come to a critical point regarding their fiscal policies (the most recent and severe case is the one of Greece). That is why ensuring fiscal sustainability is crucial. There are authors that addressed the problem of the current financial crisis, considering that government debt is expected to rise sharply, that will generate concerns that public debt will reach unsustainable levels, exposing governments to solvency risk, and raising the sovereign default.

Public debt sustainability among the advanced economies has received much attention. Various studies have been written in order to estimate the effects of the financial crisis on the fiscal policies and to investigate government's reaction to increasing public debt for both OECD and EU countries. The aim of this paper is to enrich all these studies, by providing an overall analysis of the evolution of the public debt, among the most developed European countries¹.

The essay consists of three main parts. The first one develops the simple theoretical framework within which fiscal sustainability analysis is usually conducted. The purpose of the second chapter is to provide a retrospective approach of the different empirical methods of investigation that were used by the researchers. For each model I tried to summarize the econometric background and the most notable studies that were based on this model. In the third chapter, I applied these empirical tests on a large sample of the most developed European economies. I investigated the response of advanced European governments to shocks on public debt, considering the achievement of fiscal sustainability in the long run.

2. Public Debt Sustainability – Theoretical Aspects

The need to achieve minimum standards of living, of creating employment, infrastructure and fostering growth, may run up expenses that exceed the government revenues. The government

¹ The sample consists of the following advanced economies: Belgium, Denmark, Germany, Ireland, Greece, Spain, France, Italy, the Netherlands, Austria, Portugal, Finland, Sweden, and United Kingdom.

might be able to spend in excess of its revenues, at least temporarily, through the following ways: by *issuing currency* or by *issuing debt*.

Because *issuing currency* would directly cause the money supply to extend (and this would generate inflation), most economists reject this method of financing deficits. Regarding the second method, public debt was considered undesirable for a long time. Nowadays, government borrowing is accepted as long as it is consistent with a *sound public finance*.

The principles of *sound finance* are based on the idea that structural deficits should be avoided. The first economist who supported this idea was John Maynard Keynes², at a time when France was facing major fiscal deficits. According to Keynes (1923), while a government should run deficits in recessions, these should be offset by surpluses during expansions. It is believed that permanent deficits must be avoided, because no government can operate in such a manner, as to generate the expectation that it will never be able to retire its debt.

In the context of gradual diffusion of the Keynesian theory, it was believed that debt finance is necessary to provide the proper level of aggregate demand, “when private investment is insufficient to absorb savings over a relatively long period of time”³. This assumption belongs to Evsey Domar (1944), who tried to prove that a continuous government borrowing results in an ever rising public debt, the servicing of which will require higher and higher taxes. This would eventually destroy the whole economy and result in outright repudiation of the debt (sovereign default). Domar (1944) showed that a constant overall deficit to GDP ratio ensures convergence of both the debt to GDP ratio and the interest to GDP ratio to finite values. Consequently also taxes needed to service interest payments converge to a finite value as a share of GDP.

While Domar assumed that the indebtedness degree need to converge to a finite value, in order to avoid further increasing of the tax burden, other economists (like Buiter, 1985; Blanchard, Chouraqui, Hagemann and Sartor, 1990) assumed that the indebtedness must converge to its initial level. In his paper, “A guide to public sector debts and deficits” (1985), Buiter⁴ defined a sustainable policy as one capable of keeping the ratio of public sector net worth to output at its current level.

On the other hand, Blanchard, together with Chouraqui, Hagemann and Sartor⁵ considered that fiscal policy is sustainable when public debt does not explode and governments are not forced to increase taxes, decrease spending, monetize fiscal deficit or repudiate public debt. They

² Keynes, J.M., 1923. A Tract on Monetary Reform. The Collected Writings of John Maynard Keynes, Vol.IV, Macmillan, 1971;

³ Domar, E., 1944. The Burden of the Debt and the National Income. American Economic Review, Vol.34, No.4, December, pp.798-827

⁴ Buiter, W.H., 1985. A Guide to Public Sector Debt and Deficits. Economic Policy, Vol. 21 (November), pp. 13-79;

⁵ Blanchard, O., et al. 1990. The Sustainability of Fiscal Policy: New Answers to Old Questions. OECD Economic Studies, No.15;

imposed the restriction that the present value of future primary surpluses must equal the current level of public debt. They considered that at time t , government has to borrow money to finance the primary deficit (the difference between primary expenditures, and government revenues), interest payment related to previous year, and public debt from previous year. Therefore, the equation of the government budgetary constraint is as follows:

$$B_t = G_t - R_t + B_{t-1} + iB_{t-1} = G_t - R_t + (i + 1)B_{t-1} \quad (1)$$

Where:

B_t = total amount of real public debt at time t ;

G_t = non-interest real government expenditure (including transfers and capital expenditures) at time t ;

R_t = real government revenues;

i = real interest rate for government borrowing.

This equation describes the dynamics of debt accumulation. If the government runs a primary deficit, the stock of debt will grow at a rate exceeding the interest rate and, if the government runs a primary surplus, the stock of debt will grow more slowly than the interest rate.

All the conditions mentioned above have been used in empirical studies on sustainability so that it is not always clear that different authors are talking about the same thing when they try to assess the sustainability of public finance. The absence of a clear theoretical benchmark to assess sustainability has often favored the use of ad-hoc definitions and indicators. For example, the OECD has relied only on the cyclically adjusted budget balance (CAB) as an indicator of fiscal policy. In his paper "Suggestions for a new set of fiscal indicators" (1990), Olivier Blanchard debates both the advantages and the shortcomings of CAB ("the uses and the abuses") and concludes with the fact that using only one index may be insufficient. Blanchard suggests that OECD should emphasize in its official assessments of fiscal policy, the following set of indicators:

1. *the index of discretionary change*, which should estimate what part is due to changes in the economic environment and what part is due to changes in policy;
2. *the three indicators of sustainability*: the primary gap, the medium-term tax gap and the long-run tax gap;
3. *the three indicators of fiscal impact*: the inflation adjusted deficit, the level of government spending (including real interest payments on the debt, minus the average of the tax rate over the current and the next two years), and an index which should capture the effects of retirement programs.

The confusion caused by the absence of a clear benchmark also became evident in the definitions of European Monetary Union's fiscal rules. The Treaty of Maastricht (Article 109j(1)), entered into force on 1 November 1993, requires the sustainability of the government financial

position for a country's eligibility to European Monetary Union (EMU). Article 104c(2)⁶ defines the criteria to evaluate sustainability, by providing the following reference values for deficits and debt-to-GDP ratios:

- 3% for the ratio of the planned or actual government deficit to gross domestic product at market prices;
- 60% for the ratio of government debt to gross domestic product at market prices.

Further, to make the Treaty provisions more precise and operational, in June 1997 the European Council accepted a draft resolution of the Stability and Growth Pact (SGP)⁷. The SGP is a rule-based framework for the coordination of national fiscal policies in the EMU. It was established to safeguard sound public finances, an important requirement for EMU to function properly. The Pact consists of a preventive and a dissuasive arm. Under the provisions of the preventive arm, Member States must submit annual stability or convergence programs, showing how they intend to achieve or safeguard sound fiscal positions in the medium term taking into account the impending budgetary impact of population ageing. The dissuasive part of the Pact governs the excessive deficit procedure (EDP). If it is decided that the deficit is excessive in the meaning of the Treaty, the Council issues recommendations to the Member States concerned to correct the excessive deficit and gives a time frame for doing so. Noncompliance with the recommendations triggers further steps in the procedures, including for euro area Member States the possibility of sanctions.

The long-term sustainability of public finances is also taken into consideration in the assessment of the stability and convergence programs. In the coming decades, the size and age structure of Europe's population will undergo dramatic demographic changes. Ageing populations will pose major economic, budgetary and social challenges. In response to this, the Commission published a special report, where it concluded that if EU governments continue with their current policies, government debt will increase very significantly over the coming decades. Both fiscal consolidation on the one hand and broad economic reforms on the other are needed to meet the challenge of ageing. Making a durable budgetary adjustment in this way will contribute very significantly to improving fiscal sustainability.

Another institution that encourages countries to adopt sound economic and financial policies is the International Monetary Fund (IMF). The IMF works with the World Bank to promote resilient financial systems around the world through the joint Financial Sector Assessment Program (FSAP). Supported by experts from a range of national agencies and standard-setting bodies, IMF and World Bank staffs assess the stability of a country's financial system by identifying its strengths and vulnerabilities, determine how key sources of risks are being managed, analyze the sector's development needs and help prioritize policy responses.

⁶ Source: <http://eur-lex.europa.eu/en/treaties>

⁷ Source: http://ec.europa.eu/economy_finance

The IMF main lending instrument is the Stand-by-Arrangement (SBA), created in 1952 and upgraded in 2009. All member countries facing external financing needs are eligible for SBAs subject to all relevant IMF policies. The length of a SBA is flexible, and typically covers a period of 12–24 months, but no more than 36 months. The new SBA framework has expanded the range of high access precautionary arrangements (HAPAs), a type of insurance facility against very large financing needs. Three HAPAs, with Costa Rica, El Salvador, and Guatemala, were approved during the crisis.

3. Empirical Evidence of Investigation the Public Debt Sustainability

According to the large stream of literature in this area, the classical methods of investigation can be divided into three categories:

- (1) *stationarity tests* (unit root tests);
- (2) *cointegration tests*;
- (3) *fiscal reaction function tests*.

(1) Stationarity tests:

Empirical research in macroeconomics as well as in financial economics is largely based on time series, because most of the economic indicators and variables follow a tendency, also called *trend*. According to their trend, time data series can be stationary or non-stationary⁸.

A stationary process has the property that the mean, variance and autocorrelation structure do not change over time. Stationarity means a flat looking series, without trend, constant variance over time, a constant autocorrelation structure over time and no periodic fluctuations (seasonality).

Nonstationarity, a property common to many macroeconomic and financial time series, means that a variable has no clear tendency to return to a constant value or a linear trend.

The following authors have used stationarity tests:

- Hamilton J.D. and Flavin M.A. (1985): “On the Limitations of Government Borrowing: A Framework for Empirical Testing”. They have tried to investigate whether the postwar US deficits are largely consistent with the proposition that the government budget must be balanced in present-value terms. The period of time that was taken into consideration was 1962-1984.
- Trehan B. and Walsh C. (1988): “Common trends, the government’s budget constraint and revenue smoothing”. Trehan and Walsh continued the work of Hamilton and Flavin (1985), suggesting that the total deficit instead of the primary budget balance should be of economic interest in order to conclude whether governments conduct their fiscal

⁸ Pecican, E. S., 2005. Econometrics for economists. Ed. Economică, București.

- policies in a way that the discounted future debt approaches zero. Data series used by Trehan and Walsh referred to the period of time 1890-1983.
- Wilcox D.W. (1989): "The sustainability of government deficits: Implications of the present-value borrowing constraints". Although his paper was based on the work of Hamilton and Flavin (1985) in studying the borrowing constraint, he stated that the period 1960-1984 cannot be treated as a whole, since there is strong evidence of a shift in the structure of fiscal policy.
 - Trehan B., Walsh C. (1991): "Testing intertemporal budget constraints: Theory and applications to US federal budgets and current account deficits". In this paper, the set of data comprised annual values for public debt and budgetary deficit, for the US, in the period 1960-1984. The authors derive the implication that sufficient and necessary conditions for intertemporal budget constraint to be satisfied are cointegration relationship between primary deficit and debt time series and stationarity in the quasi-difference of the primary deficit.
 - Corsetti G. and Roubini N. (1991): "Fiscal deficits, public debt and government solvency: Evidence from OECD countries". This paper provided an application to a sample of 18 OECD countries, in 1960-1989. The authors detected wide differences across countries in the long term sustainability. Major OECD countries (like US, Japan, Germany, France, The UK and Canada) did not appear to face solvency issues. Among the smaller OECD countries, problems of sustainability appeared to exist in Belgium, Ireland, Netherlands and Greece, countries that had in common a large debt to GDP ratio (above 100% in Belgium and Ireland).
 - Caporale G. (1995): "Bubble finance and debt sustainability: a test of the government's intertemporal budget constraint". Caporale tested deficit and public debt stationarity for EU countries in 1960-1991.
 - Makrydakis J.S, Tzavalis E. and Balfoussias A. (1999): "Policy regime changes and long run sustainability of fiscal policy: An application to Greece". They considered annual data series for the period 1958-1995. The empirical evidence showed the failure of the Greek government to satisfy intertemporal budget balance in the long-run and identified as the cause of this failure a deterministic policy regime shift in 1979.
 - Greiner A. and Semmler W. (1999): "An inquiry into the sustainability of German fiscal policy: some time series tests". Using annual data from 1955 to 1994, the results seem to indicate that the intertemporal budget constraint for Germany is not met. In particular, the deficits in the period after 1989 appear to have contributed to that trend.
 - Uctum M., Wickens M. (2000): "Debt and deficits ceilings, and sustainability of fiscal policy: An intertemporal analysis". Concerning the restrictive ceilings in deficits and debt, the authors considered that imposing 3% deficit limits and 60% debt limits throws most governments' budget onto an unsustainable path, unless they generate major primary surpluses.

(2) Cointegration tests:

An *integrated* time series is a nonstationary series that can be converted into a stationary series by calculating the first order differences. In this case, the time series will be integrated of order I. If the tendency was not removed completely, it is recommended to proceed to the calculation of the second order differences. In this case, the time series will be integrated of order II. Finally, we will obtain a stationary time series (integrated of order zero).

If two or more series are individually integrated, but some linear combination of them has a lower order of integration, then the series are said to be *cointegrated*. If x_t and y_t are both integrated of order I and can compose a linear combination $z_t = y_t - (a_0 + a_1x_t)$, which is integrated of order zero, then the series x_t and y_t are cointegrated. It is assumed that a long term equilibrium relationship is established between cointegrated time series.

The authors stated three hypothesis which give details about the influence that budgetary revenues and expenditures has on each other⁹. For instance:

- When the causality relationship between the two variables is bidirectional, it is confirmed fiscal synchronization hypothesis (on long term, expenditure decisions are not made in isolation from revenue decisions);
- When the causality relationship runs from revenues to expenditures, it is confirmed revenues-expenditures hypothesis (the spending level adjust to changes in revenue);
- When the causality relationship runs from expenditures to revenues, it is confirmed expenditures-revenues hypothesis (changes in spending induce changing in revenues).

Among the most important studies that have used cointegration tests, we can include those that belong to:

- Elliot G. and Kearney C.(1988): “The intertemporal government budget constraint and tests for bubbles”. This paper used cointegration methods to test for bubble financing of the fiscal deficit for Australia. The results showed that over the period 1953/54 to 1986/87 there was no evidence of unsustainability of government debt. However, it seems that seigniorage was used to pay for sustained fiscal deficits, and that the overall level of debt as a ratio of GDP fell over the period as a result of strong GDP growth and inflation.
- Hakkio G. and Rush M. (1991): “Is the budget deficit too large?”. The authors used quarterly values for revenues and expenditures, in 1950:II-1988:IV. The results showed that government spending was growing more rapidly than government revenue. Hakkio and Rush found that interest-inclusive expenditures are not cointegrated with revenues over the period 1964 to 1989, which means that the government debt appears to drift

⁹ Fasano U.; Wang Q., 2002. Testing the relationship between government spending and revenue: Evidence from GCC Countries, International Monetary Fund, November 2002.

upward without bound. Overall, the results showed that the government will have an incentive to default on the debt at some point in the future.

- Tanner E. and Liu P. (1994): "Is the budget deficit too large? Some further evidence". Studies such as Tanner and Liu point to the presence of sustainability in the context of US deficit process that has undergone at least one structural shift during recent decades. The authors believed that a discrete break in the fiscal process occurred in the early 1980s as a result of several policy changes, such as the 1981 Economic Recovery and Tax Act, during the first Reagan administration. They found evidence against the conclusions by Hakkio and Rush, arguing that the null hypothesis of no cointegration is rejected for the periods of 1950-1989 and 1964-1989, and the coefficient of cointegration is not statistically different from unity.
- Quintos C. (1995): "Sustainability of the deficit process with structural shifts". The set of data comprised quarterly values for public revenues and expenditures, in the period 1947:II-1992:III. For tests on structural shifts, Quintos used a test for structural change that searched for shifts in the rank of the cointegrating matrix and found out that there was a shift in deficit policy in the early 80s, so that cointegration between revenue and expenditure inclusive of interest payments holds only up to 1980. The author concluded that the deficit process was still sustainable, despite the failure of cointegration in the 80s.
- Haug A. (1995): "Has Federal budget deficit policy changed in recent years?". Although others researchers (like Hakkio and Rush, Tanner and Liu, etc.) have argued that fiscal policy under Presidents Reagan and Bush moved the U.S. deficit onto an unsustainable path, Haug's results suggested that government deficit policy in the 1980s was not significantly different from policies during the three earlier decades.
- Payne J. (1997): "International evidence on the sustainability of budget deficits". This paper examined the sustainability of budget deficits of the G-7 countries, in 1949-1994. Following the approach taken by Hakkio and Rush, Payne found that in the case of Germany it appears that for each dollar increase in expenditures, revenues increased by an equal amount. For France, Japan, and Italy, the budget deficits of these countries might not be sustainable due to the lack of cointegration. In the cases of Canada, United Kingdom, and the United States, cointegration was present between revenues and expenditures. However, the estimated coefficients on expenditures for these countries are significantly less than one which suggests that government spending was growing faster than government revenue.
- Stoian A. (2008): "Analysing causality between Romania's public budget expenditures and revenues". In order to investigate the causality between Romania's public budget expenditures and revenues, the author used quarterly data between 1991-2005. Using Johansen cointegration test, it was revealed the existence of a long run equilibrium relationship between budgetary expenditures and revenues. This equilibrium relationship depends on the error correction mechanism, that will prevent large fiscal

imbalances. The author also showed that budgetary revenues could be estimated based on its own past values.

(3) Fiscal reaction function tests:

The third method of investigation, the fiscal reaction function test, establishes how government reacts to its debt burden. This methodology became used to a large extent in those cases when classical tests (e.g. unit root test) fail due to some issues affecting time series (structural breaks, lack of data, etc.).

The fiscal reaction function is based on equation of the government budgetary constraint that was described in our previous section (equation 1). This equation will be gradually processed, in order to obtain the following results:

$$-p_t = \frac{i - g}{1 + g} b_{t-1} \quad (2)$$

$$p_t = f(b_{t-1}) + \varepsilon \quad (3)$$

According to the above result, there is a positive relationship between indebtedness and the primary balance. Consequently, the fiscal reaction function can be estimated by regressing primary balance on the public debt.

Moreover, equation (2) can be also seen as a fiscal rule that estimates the required primary surplus that stabilizes the ratio of public debt.

Studies investigating fiscal reaction function make use of various extra explanatory variables, such as: business cycle, lagged primary balance, lagged debt to GDP, square or cubic, temporary government spending, inflation, interest rate, social surplus, fiscal rules, institutions, etc. All these extra independent variables can be summarized through a single variable. Therefore, a much general form of fiscal reaction function is as follows:

$$p_t = f(b_{t-1}) + Z_t + \varepsilon \quad (4)$$

The empirical studies based on the fiscal reaction tests were those written by:

- Bohn H. (1998): “The behavior of U.S. public debt and deficits ” . In this paper, Bohn tried to establish how the US government reacted to the accumulation of the public debt, in the period 1916-1995. He showed that the U.S. government had historically responded to increases in the debt-GDP ratio by raising the primary surplus, or equivalently, by reducing the primary deficit.

- De Mello L. (2005): Estimating a fiscal reaction function: The case of debt sustainability in Brazil". The empirical analysis, based on monthly data for the period 1995-2004, suggested that all levels of government reacted strongly to changes in indebtedness by adjusting their primary budget surplus targets. In addition, the central government appeared to follow a spend-and-tax policy: changes in revenue were affected strongly by expenditure.
- Câmpeanu E., Stoian A., Roman M. (2006): "Fiscal sustainability based on reaction function: Case study Romania". The authors used quarterly data spanned on 1991-2005, in order to investigate Romanian fiscal sustainability. Due to the historical background of this country, they considered that classical methods of investigation are not so relevant. Therefore, they tried to assess sustainability by estimating the fiscal reaction function and by using Ordinary Least Squares (OLS). The conclusion was that Romania's fiscal policy was characterized by a weak sustainability.
- Mendoza E. G., Ostry J. D. (2007): "International evidence on fiscal solvency: Is fiscal policy responsible?". This paper analyzed the issue of fiscal sustainability for a large panel of both industrial and emerging market countries. Drawing on a dataset for 34 emerging market and 21 industrial countries over the period 1990-2005, the authors developed the "Model-based Sustainability (MBS) approach, proposed by Bohn (1998). The conclusion was that there is indeed strong empirical evidence of a robust positive conditional relationship between primary surpluses and public debt for both emerging and advanced markets.
- Mendoza et al.(2011): "Fiscal fatigue, fiscal space and debt sustainability in advanced economies" . This essay investigates whether the advanced economies have room for fiscal maneuver (they called this "fiscal space") or whether they need urgent fiscal adjustment for debt sustainability. In this sense, it was developed a model based on the fiscal reaction function. It was determined a debt limit beyond fiscal solvency is in doubt and it was defined fiscal space as the distance between the current debt level and this debt limit. Applying their framework empirically to a sample of 23 advanced economies over the period 1970–2007, the authors found strong support for the existence of a non-linear relationship between the primary balance and (lagged) public debt that exhibits the fiscal fatigue characteristic. The results indicated that Greece, Italy, Japan, and Portugal have the least fiscal space, with Iceland, Ireland, Spain, the United States, and the United Kingdom also constrained in their degree of fiscal maneuver. By contrast, Australia, Korea, New Zealand, and the Nordic countries appeared to have the most fiscal space to deal with unexpected shocks.

4. Data and Results for the Advanced European Union Countries

Since 1992 the EU countries have been compelled to make efforts to actively control their public accounts and to converge in nominal terms. First, the Maastricht Treaty (MT) defined the

budgetary rules – in addition to the criteria for inflation reduction, interest rate convergence and exchange rate stability – that countries had to satisfy in order to take part in the Economic and Monetary Union (EMU): the 3% of GDP deficit rule and the 60% of GDP debt rule. Then, these same fiscal rules were reinforced in the Stability and Growth Pact (SGP) for countries in the EMU.

The main justification for using rules to limit the degree of fiscal policy discretion is the fact that governments seem to have an inherent propensity to run excessive deficits and debts. Several studies have been written to identify the factors that influence public deficits in both OECD countries and EU countries over the last decades. As it was stated before, the aim of this paper is to enrich all these studies, by providing an overall analysis of the evolution of the public debt, among the most developed European countries. In order to provide a compelling appraisalment of this topic, I tried to use multiple methods of investigation:

- unit-root tests (Augmented Dickey-Fuller test), to assess whether the debt ratio time series was stationary or not;
- cointegration tests (Johansen test), to establish the influence that budgetary revenues and expenditures has on each other;
- fiscal reaction function tests, to establish how the actual primary surplus reacts to changes of the actual public debt;
- the fiscal rule test, that calculates a stabilizer primary balance and compares it with the average primary balance for each country.

For all these tests, we used annual data (provided by Ameco)¹⁰, spanned mostly on 1970-2012. It is important to notice that, during all this period, many of the countries have faced the tendency of increasing public debt ratio. This situation could be explained considering the rise of government expenditures and social transfers. In order to strengthen the welfare of the state, in the last forty years there has been an extraordinary increase in the share of government spending in total national income throughout the industrial world.

In the case of the advanced European countries, empirical evidence reveals that during 1991-2012 the average public debt growth rate exceeded average economic growth rate in many countries, except Austria, Belgium, Denmark, Ireland, the Netherlands and Sweden. In these countries, the upper trend of the public debt had a downturn few years after the enforcement of the MT.

¹⁰ Although for most countries data was available for the entire period 1970-2012, there were some exceptions, like: France (1977-2012), Germany (1991-2012), Netherland (1975-2012), Portugal (1977-2012), Denmark (1971-2012). Another important exception is that related to the implicit interest rate. For all the countries of our sample, this indicator was available only for the period 1995-2012. Therefore, it was considered only this period when establishing if the level of the primary balance is consistent with the fiscal rule.

The implicit interest rate on public debt was higher than the growth rate for all the economies from our sample. Average values for public debt growth rate, GDP growth rate and implicit interest rate were summarized in table below:

Table 1 Average public debt growth rate, GDP growth rate and implicit interest rate on public debt

Country	Debt growth rate	GDP growth rate	Interest rate
Austria	1.42	2.05	5.27
Belgium	-1.09	2.77	5.79
Denmark	-0.69	1.65	6.59
Finland	8.05	2.1	5.99
France	4.32	1.59	5.46
Germany	3.6	1.4	5.23
Greece	4.15	2.06	8.32
Ireland	3.21	4.56	5.36
Italy	1.15	0.96	6.96
Netherland	-0.57	2.22	5.92
Portugal	3.42	1.52	7.33
Spain	2.87	2.71	5.35
Sweden	-0.5	2.72	4.57
UK	4.9	1.99	6.27

What may be considered a paradox is the fact that public debt ratio had an upward trend, even after the enforcement of the Maastricht Treaty. This proves that many countries had difficulties in coping with a ratio less than 60%. The average ratio of the public debt before and after MT is stated in table below:

Table 2 Descriptive statistics for public debt before and after MT

Country	Average debt ratio (all data)	Average debt ratio before MT	Average debt ratio after MT	StDev all data	StDev before MT	StDev after MT
Austria	51.14	37.79	66.49	18.41	15.27	3.97
Belgium	97.33	89.34	106.51	25.67	29.94	15.88
Denmark	47.54	43.63	51.85	21.94	26.53	14.96
Finland	29.10	13.67	46.85	18.14	7.10	7.03
France	48.31	28.67	64.03	20.03	6.41	11.04
Greece	70.76	36.75	109.88	42.45	21.15	21.33
Ireland	68.83	77.20	59.20	28.05	23.30	30.47
Italy	88.98	68.25	112.81	27.01	19.69	6.73
Netherland	60.25	59.81	60.65	12.81	15.53	10.15
Portugal	56.32	45.32	65.13	17.78	10.74	17.54
Spain	39.86	26.10	55.68	19.22	13.62	10.43
Sweden	47.51	41.70	54.19	15.18	14.20	13.71
UK	52.87	53.73	51.87	13.73	12.12	15.64

The criteria which sets the threshold of 60% of GDP for the public debt ratio is a frequently used benchmark by European Commission and IMF. However, it might not be so relevant. There are situations when countries with a larger ratio than the threshold can remain solvent, as long as public debt policy is characterized by a good management and large primary surpluses are predicted in the future. There are also situations when a ratio considerably lower than 60% is not consistent with a sound public finance. Political instability and the ongoing costs associated with frequent changes in fiscal and monetary policies can affect the public debt sustainability in the long run¹¹. Therefore, the limits for deficit and public ratio imposed by MT do not always reflect the ability of a government to sustain its borrowings. However, in this study it was used this criteria, because in the absence of a clear benchmark, it is very difficult to assess public debt sustainability for the countries surveyed.

The empirical analysis shows that the upward trend of the public debt ratio alternated with some weak decreases in the period between the enforcement of the MT and the year 2007. Once the economic and financial crises began, the debt ratio expanded. There is a clear evidence for all of the advanced European economies on the accumulation of public debt since 2007. Unfortunately, the forecasted levels for the public debt ratio (%of GDP) for 2012 are not at all encouraging (see Table 3):

¹¹ For example, we have the case of Romania, where the government consolidated gross debt was 30.8% of GDP. Even if this ratio is considerably lower than the threshold and than the UE27 average (80% in 2010), the fact that Romanian public finance reform has been an undergoing process of many transformations from a central planned state to a democracy may have serious implications on the country's external credibility.

Table 3 Public debt ratio for 2012 (forecasted levels)

Country	Debt ratio	Country	Debt ratio
Austria	75.41	Ireland	117.93
Belgium	97.47	Italy	119.81
Denmark	47.12	Netherland	63.97
Finland	52.19	Portugal	107.41
France	86.84	Spain	70.99
Germany	81.05	Sweden	33.37
Greece	166.15	UK	87.95

There are concerns about the fact that some governments will be exposed to solvency risk, that could lead to sovereign default. It is the case of Greece, which needed unprecedented fiscal adjustments through a program monitored by the IMF. Greece is highly indebted and lost about 25 percent of its competitiveness since Euro adoption. At the end of 2009, the general public deficit reached 13.6% of GDP and public debt had increased to 127% of GDP. In past years, Greece's public sector spending grew, while revenue fell. Then the global recession hit, economic activity slowed and unemployment rose. This exacerbated the fiscal situation. There are rumors about the fact that government will fail to ensure the proper functioning of the fiscal measures and soon the Greek authorities will lose ownership and leadership in collecting their revenues. Moreover, the high debt and the lack of competitiveness in Greece will hit all the European members that are economic and financial connected with this country. Greece is not an isolated case of unsound fiscal policy and solvency risk. Many countries were affected by the financial turmoil and now they have problems in ensuring a good public debt policy management. The first step in identifying those countries with sustainability issues is to test for the unit roots on the time series considered¹². The analysis reveals that no country had a stationary public debt in level (except Germany, but only for 90% probability). As I mentioned before, the database is built on the information provided by Ameco. However, the information is not homogeneous, which means that for some countries, each macroeconomic variable (public debt ratio, primary balance, public expenditures, public revenues, etc.) is available for different periods of time.

Therefore, in the attempt to estimate the fiscal reaction function, I tried to build a homogeneous database, because the indicators covered by the analysis should be spanned on a common period of time. The results of the unit-root tests for both public debt and primary balance are as follows:

¹² For the ADF test, I considered the following time series: public debt ratio and primary balance ratio (both were expressed as percentage of GDP). The constant and/or trend were considered accordingly.

Table 4 ADF test for public debt and primary balance time series

Country	Stationarity	Public debt ratio				Primary balance ratio			
		[t-stat] (prob)	1%	5%	10%	[t-stat] (prob)	1%	5%	10%
Austria (1976-2012)	Level	[-2.34] (0.39)	-4.24	-3.54	-3.2	[-3.62] (0.01)	-3.62	-2.94	-2.61
	First difference	[-2.79] (0.00)	-2.63	-1.95	-1.61	[-6.20] (0.00)	-2.63	-1.95	-1.61
Belgium (1970-2012)	Level	[-1.95] (0.30)	-3.6	-2.93	-2.6	[-1.60] (0.47)	-3.59	-2.93	-2.61
	First difference	[-2.45] (0.01)	-2.62	-1.94	-1.61	[-8.17] (0.00)	-2.62	-1.94	-1.61
Denmark (1971-2012)	Level	[-2.45] (0.13)	-3.6	-2.93	-2.6	[-3.26] (0.02)	-3.61	-2.93	-2.61
	First difference	[-2.74] (0.00)	-2.62	-1.94	-1.61	[-4.24] (0.00)	-2.62	-1.94	-1.61
Finland (1975-2012)	Level	[-1.25] (0.64)	-3.63	-2.94	-2.61	[-3.12] (0.03)	-3.62	-2.94	-2.61
	First difference	[-3.96] (0.00)	-2.63	-1.95	-1.61	[-4.97] (0.00)	-2.63	-1.95	-1.61
France (1978-2012)	Level	[-3.07] (0.12)	-4.26	-3.55	-3.21	[-2.19] (0.21)	-3.63	-2.95	-2.61
	First difference	[-2.55] (0.01)	-2.63	-1.95	-1.61	[-5.27] (0.00)	-2.63	-1.95	-1.61
Germany (1991-2012)	Level	[-3.54] (0.06)	-4.49	-3.65	-3.26	[-3.48] (0.01)	-3.81	-3.02	-2.65
	First difference	[-2.72] (0.00)	-2.69	-1.96	-1.61	[-4.40] (0.00)	-2.68	-1.95	-1.61
Greece (1988-2012)	Level	[1.10] (0.99)	-3.73	-2.99	-2.63	[-1.67] (0.42)	-3.73	-2.99	-2.63
	First difference	[-2.36] (0.02)	-2.66	-1.95	-1.6	[-4.95] (0.00)	-2.66	-1.95	-1.61
Ireland (1985-2012)	Level	[-1.25] (0.63)	-3.73	-2.99	-2.63	[-2.17] (0.21)	-3.69	-2.97	-2.62
	First difference	[-2.99] (0.00)	-2.66	-1.95	-1.6	[-4.44] (0.00)	-2.66	-1.95	-1.61
Italy (1980-2012)	Level	[-2.61] (0.10)	-3.66	-2.96	-2.61	[-1.42] (0.55)	-3.65	-2.95	-2.61
	First difference	[-2.24] (0.02)	-2.64	-1.95	-1.61	[-5.92] (0.00)	-2.64	-1.95	-1.61

Table 4 ADF test for public debt and primary balance time series (continued)

Netherland (1975- 2012)	Level	[-2.04] (0.26)	-3.62	-2.94	-2.61	[-2.65] (0.09)	-3.62	-2.94	-2.61
	First difference	[-3.38] (0.00)	-2.63	-1.95	-1.61	[-5.85] (0.00)	-2.63	-1.95	-1.61
Portugal (1977- 2012)	Level	[0.64] (0.99)	-4.24	-3.54	-3.2	[-2.75] (0.07)	-3.63	-2.94	-2.61
	First difference	[-2.96] (0.00)	-2.63	-1.95	-1.61	[-5.52] (0.00)	-2.63	-1.95	-1.61
Spain (1995- 2012)	Level	[-2.59] (0.11)	-3.92	-3.06	-2.67	[-2.31] (0.17)	-3.92	-3.06	-2.67
	First difference	[-1.69] (0.08)	-2.71	-1.96	-1.6	[-3.95] (0.00)	-2.72	-1.96	-1.6
Sweden (1993- 2012)	Level	[-2.70] (0.24)	-4.53	-3.67	-3.27	[-2.87] (0.06)	-3.85	-3.04	-2.66
	First difference	[-2.73] (0.00)	-2.69	-1.96	-1.6	[-3.25] (0.00)	-2.69	-1.96	-1.6
UK (1970- 2012)	Level	[-2.16] (0.22)	-3.6	-2.93	-2.6	[-3.02] (0.04)	-3.6	-2.93	-2.6
	First difference	[-2.94] (0.00)	-2.62	-1.94	-1.61	[4.67] (0.00)	-2.62	-1.94	-1.61

Most of the time series were stationary in their first difference, but it cannot be used the first difference in our further regressions. The fiscal reaction function model assumes that public debt ratio and primary balance time-series are stationary in level and this hypothesis¹³ cannot be modified. Based on the results of ADF test, fiscal reaction function model in its original form may be applied only in the case of Germany and for a significance level of 10.

Consequently, it will be estimated the government's response to the increasing debt, by regressing the primary balance on the public debt, in accordance with the model described in the previous section by equation (3). The results of the OLS estimation are presented in the table below:

Table 5 Fiscal reaction function in the case of Germany

	Indicators	Values
	R square	0.001769
	Adjusted R square	-0.050770
	F	0.033667
	Significance F	0.856361
Intercept	Coefficient	0.370827
	P-value	0.838179
	t-stat	0.207042
X Variable 1	Coefficient	0.005287
	P-value	0.856361
	t-stat	0.207042

¹³ However, the first-difference stationarity may prove useful later on, when it will be studied the cointegration between public debt and primary balance.

Following the statistical results, it cannot be discussed the response of the German government to increasing public debt.

In order to draw a relevant conclusion about the sustainability of the public debt, I considered it appropriate to apply cointegration test also between public expenditures and public revenues. ADF test reveals the following results:

Table 6 ADF test for public expenditures and public revenues time series

Country	Stationarity	Expenditures ratio				Revenues ratio			
		[t-stat] (prob)	1%	5%	10%	[t-stat] (prob)	1%	5%	10%
Austria (1976- 2012)	Level	[-2.61] (0.09)	-3.62	-2.94	-2.61	[-3.38] (0.01)	-3.62	-2.94	-2.61
	First difference	[-5.79] (0.00)	-2.63	-1.95	-1.61	[-5.61] (0.00)	-2.63	-1.95	-1.61
Belgium (1970- 2012)	Level	[-2.54] (0.11)	-3.59	-2.93	2.6	[-2.87] (0.05)	-3.59	-2.93	2.6
	First difference	[-6.90] (0.00)	-2.62	-1.94	-1.61	[-5.85] (0.00)	-2.62	-1.94	-1.61
Denmark (1971- 2012)	Level	[-2.45] (0.13)	-3.6	-2.93	-2.6	[-2.42] (0.14)	-3.61	-2.93	-2.6
	First difference	[-4.65] (0.00)	-2.62	-1.94	-1.61	[-4.12] (0.00)	-2.62	-1.94	-1.61
Finland (1975- 2012)	Level	[-2.29] (0.17)	-3.62	-2.94	-2.61	[-2.12] (0.23)	-3.62	-2.94	-2.61
	First difference	[-3.36] (0.00)	-2.63	-1.95	-1.61	[-6.61] (0.00)	-2.63	-1.95	-1.61

Table 6 ADF test for public expenditures and public revenues time series (continued)

France (1978-2012)	Level	[-2.39] (0.15)	-3.63	-2.95	-2.61	[-3.76] (0.00)	-3.63	-2.95	-2.61
	First difference	[-3.89] (0.00)	-2.63	-1.95	-1.61	[-4.95] (0.00)	-2.63	-1.95	-1.61
Germany (1991-2012)	Level	[-1.92] (0.31)	-3.78	-3.01	-2.64	[-1.40] (0.56)	-3.78	-3.01	-2.64
	First difference	[-4.70] (0.00)	-2.68	-1.95	-1.6	[-4.94] (0.00)	-2.68	-1.95	-1.6
Greece (1988-2012)	Level	[-2.23] (0.20)	-3.73	-2.99	-2.63	[-2.31] (0.17)	-3.73	-2.99	-2.63
	First difference	[-5.87] (0.00)	-2.66	-1.95	-1.6	[-3.59] (0.00)	-2.66	-1.95	-1.6
Ireland (1985-2012)	Level	[-2.29] (0.17)	-3.69	-2.97	-2.62	[-1.27] (0.62)	-3.69	-2.97	-2.62
	First difference	[-6.04] (0.00)	-2.65	-1.95	-1.6	[-4.40] (0.00)	-2.65	-1.95	-1.6
Italy (1980-2012)	Level	[-3.36] (0.02)	-3.65	-2.95	-2.61	[-2.42] (0.14)	-3.65	-2.95	-2.61
	First difference	[-4.75] (0.00)	-2.64	-1.95	-1.61	[-4.66] (0.00)	-2.64	-1.95	-1.61
Netherland (1975-2012)	Level	[-0.93] (0.76)	-3.62	-2.94	-2.61	[-1.09] (0.70)	-3.62	-2.94	-2.61
	First difference	[-4.07] (0.00)	-2.63	-1.95	-1.61	[-5.78] (0.00)	-2.63	-1.95	-1.61
Portugal (1977-2012)	Level	[-1.95] (0.30)	-3.63	-2.95	-2.61	[-2.08] (0.25)	-3.64	-2.95	-2.61
	First difference	[-4.86] (0.00)	-2.63	-1.95	-1.61	[-5.52] (0.00)	-2.63	-1.95	-1.61
Spain (1995-2012)	Level	[-2.19] (0.21)	-3.92	-3.06	-2.67	[-2.64] (0.10)	-3.92	-3.06	-2.67
	First difference	[-2.57] (0.01)	-2.71	-1.96	-1.6	[-3.89] (0.00)	-2.71	-1.96	-1.6
Sweden (1993-2012)	Level	[-3.57] (0.01)	-3.83	-3.02	-2.65	[-1.16] (0.66)	-3.83	-3.02	-2.65
	First difference	[-2.52] (0.01)	-2.69	-1.96	-1.6	[-4.51] (0.00)	-2.69	-1.96	-1.6
UK (1970-2012)	Level	[-2.80] (0.06)	-3.6	-2.93	-2.6	[-2.23] (0.19)	-3.6	-2.93	-2.6
	First difference	[-3.95] (0.00)	-2.62	-1.94	-1.61	[-4.93] (0.00)	-2.62	-1.94	-1.61

As can be seen, the public expenditures and the public revenues are I(1) for most of the countries, with the following exceptions: Austria, France, Italy and Sweden. The exceptions will be analyzed later on, after applying the last test, based on the fiscal rule. For the moment, we will consider only the Johansen test's results, which are as follows:

Table 7 Testing cointegration between public expenditures and public revenues

Country	Number of cointegrating equations (CE)	Normalized coefficients	
		Expenditures	Revenues
Belgium	no CE		
Denmark	2 CE	1.00000	-1.188687 (0.20780)
Finland	no CE		
Germany	no CE		
Greece	1 CE	1.00000	7.872501 (2.23735)
Ireland	no CE		
Netherland	1 CE	1.00000	-1.478700 (0.09243)
Portugal	1 CE	1.00000	-0.894333 (0.07778)
Spain	2 CE	1.00000	-14.64878 (3.54622)
UK	2 CE	1.00000	-1.081377 (0.28864)

According to these results, in the cases of Denmark, Greece, the Netherlands, Portugal, Spain and UK, cointegration was present between expenditures and revenues, which prove a healthy budgetary policy. Therefore, there is a high probability that these countries' governments will manage to avoid large fiscal imbalances in the future. In the case of the Netherlands and Sweden, the two Johansen tests that we applied (between public debt and primary balance and between expenditures and revenues) lead to the same conclusion: their governments react to the accumulation of the debt and take corrective measures, such as establishing synchronization between the fiscal income and the required expenses. For Belgium, Finland, Germany and Ireland, the budget deficits of these countries might not be sustainable due to the lack of cointegration. Therefore, on long term, expenditure decisions are made in isolation from revenue decisions. The situation is not so difficult in Finland's case. Although Johansen test reveals a lack of cointegration, the low ratio of public debt and the high primary surplus creates the prerequisites for a balanced and sustainable fiscal policy¹⁴. The existence of a higher primary surplus than necessary is also proved by the following test, the fiscal rule.

When it was analyzed the econometric background of the fiscal reaction function, it was mentioned that equation (2) can be seen as a fiscal rule that estimates the required primary surplus that stabilizes the ratio of public debt.

¹⁴ It should be noted that Finland had the lowest average public debt ratio, before the enforcement of the MT (29.10%), as well as after MT (46.85%)

The actual primary surplus was noted p_t and the stabilizer primary surplus was noted p_t^* . The average levels of these two indicators are summarized below¹⁵:

Table 8 The stabilizer primary balance

Austria	pt	0.54	yes	Ireland	pt	0.19	yes
	pt*	2.03			pt*	0.77	
Belgium	pt	3.49	no	Italy	pt	2.53	yes
	pt*	3.42			pt*	6.51	
Denmark	pt	3.39	no	Netherland	pt	1.75	yes
	pt*	2.67			pt*	2.36	
Finland	pt	2.44	no	Portugal	pt	-0.86	yes
	pt*	1.33			pt*	3.50	
France	pt	-1.01	yes	Spain	pt	-0.12	yes
	pt*	2.07			pt*	1.41	
Germany	pt	0.69	yes	Sweden	pt	2.90	no
	pt*	2.14			pt*	1.13	
Greece	pt	-0.28	yes	UK	pt	-1.44	yes
	pt*	6.04			pt*	1.92	

The results show that for Belgium, Denmark, Finland and Sweden, the long-run primary balance-to-GDP ratio that the government ran exceeded the primary balance-to-GDP ratio required to stabilize debt and to ensure sustainability. In the cases of Spain, France, Greece, Portugal and UK, the response of the government was opposite than expected. During the period 1991-2012, the government ran primary deficit rather than surplus. This can cause difficulties in the long run taking into account that actual primary deficit is larger than it is required to be during the analyzed period of time. In the rest of the countries (Austria, Germany, Ireland, Italy and the Netherlands), the fiscal policy generated primary surplus, but the amount was not large enough to cover the required one.

4. Concluding remarks

The empirical evidence revealed the fact that applying multiple tests could lead to different conclusion. It is important to understand that assessing public debt sustainability is a quite difficult process and that there is no simple rule to follow, in order to draw an exact conclusion. As Nouriel

¹⁵ For this test, we considered only the period 1991-2012, because of the lack of data regarding the implicit interest rate. The only possibility to build a homogeneous database was to choose a common period of time for all countries.

Roubini mentioned in one of his papers¹⁶, only a systematic analysis of indicators, through a set of methods and tests, can provide an accurate assessment.

The first test, the fiscal reaction function, could be used in its original form only in the case of Germany. But the OLS estimation did not show a significant reaction of the primary balance to the increasing public debt. In Germany, the situation is quite severe, as the tests reveal no cointegration between the public expenditures and the public revenues and at this we can add a level of the primary surplus lower than the one that could stabilize the budget. Since 2003, the ratio of the public debt was higher than the threshold imposed by the Maastricht Treaty. In fact, this is a common aspect for most of the countries. With the exception of Denmark, Finland and Sweden, all the advanced economies in the European Union show a debt ratio to GDP greater than the required one. This situation had worsened once the economic and financial crises began. Since 2007, all the countries of our sample have faced the tendency of increasing public debt ratio. In the last years, some of them reached alarming levels.

As it can be observed from our analysis, there are only a few countries that are not in danger to face solvency risk in the future. It is the case of Denmark, Finland, the Netherlands and Sweden. The sustainability of their fiscal position is generated by a public debt ratio that does not surpass the threshold, as well as by a primary surplus large enough to cover the stabilizer one (except the Netherlands).

In the case of Denmark, the tests reveal cointegration between expenditures and revenues, while Sweden shows cointegration between public debt and primary balance. The Netherlands is this only country that shows cointegration between the expenditures and revenues, as well between public debt and primary balance.

Unfortunately, the other countries of our sample are far away from reaching such positive results. According to our empirical evidence, countries like France, Ireland, Italy, Portugal, Spain and UK are over-indebted and the credit markets are already concerned about their ability to service their debts. They have huge debt ratios and they also run primary deficits or very low surpluses, unable to equal the primary balance-to-GDP ratio required to stabilize debt. At least some of them (Portugal, Spain, UK) show cointegration between revenues and expenditures, which means that the fiscal decisions were not taken at random.

According to Johansen test, cointegration is present also in Greece. This is the only positive result for this country. All the other tests lead to the following conclusion, which is sustained by the actual economic and fiscal situation: Greece is highly indebted and needs unprecedented fiscal adjustments through a program monitored by the IMF. Moreover, the high debt and the lack of competitiveness in Greece will hit all the European members that are economic and financial

¹⁶ Roubini, N., 2001. Debt Sustainability: How to Assess Whether a Country is Insolvent. Stern School of Business, New York University

connected with this country. Time will tell if these concerns will be justified in the long-run. Meanwhile, it is crucial for the over-indebted countries to manage their public finances in a right way, and to take corrective measures so as to ensure public debt sustainability and to minimize the solvency risk.

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