

Public Debt Sustainability: The Case of Greece

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Abstract: The purpose of this study is to examine whether the Greek public debt will be sustainable up to 2020. To this end, we develop a debt sustainability model and carry out an empirical investigation based on a system of four equations for the period 1980-2009. By conducting a number of simulations, we find that the change of public debt to GDP ratio decreases when the primary deficit decreases or the growth rate increases, while this ratio rises when the real interest rate increases. Finally, adopting scenarios of public debt sustainability for the period 2013-2020, we find out that the debt can be sustainable in the case of high primary surpluses or high growth rates. However, surpluses and growth rates may be lower if the revenues from privatizations or an additional haircut are introduced into the analysis.

Keywords: Public debt, Greece, sustainability, scenarios, deficit, growth rate, interest rate.

1. INTRODUCTION

A lot of economists, academicians and government officials tend to believe that public debt management is so important as a means of implementing stabilization and growth targets that a fully fledged analysis of its rules and its consequences is required. For instance, Wolswijk and De Haan (2005) claimed that the contents of the public debt management problem in the euro area countries have been revised significantly since the foundation of Eurozone in 1999. In Euro area any exchange rate risks have been eliminated but the euro area countries have to abide by the strict provisions of the Maastricht agreement, as for example the "60% rule of public debt" and the "3% rule of deficit". Unfortunately, a lot of Eurozone countries have defied the fiscal commitments and they are now asking for financial aid from the European Stabilization Mechanism (ESM). This is the case for the southern countries of the euro area. Greece is in a quasi-default state. Portugal is also a problematic economy with difficulties in financing its deficits. Italy is an example of a developed industrial country but it is treated as being a state of overindebtedness. Spain already emerges as a threat to the viability of Eurozone. The Spanish economy is classified among the four strongest ones in the Eurozone but the Spanish bank system runs the danger of collapse. Thus, reconsiderating public debt management in the euro area and the relevant sustainability issue is of significant importance.

For our empirical investigation we used data of the Greek economy. We chose Greece because it is an overindebted country with a high possibility of default. On May 2010 the Greek government approved the

funding program recommended by the International Monetary Fund, the European Central Bank and European Commission (Troika). However, despite that tax increases and expenditure cuts have significantly squeezed the purchasing power of the households, the Greek policymakers have failed to make any remarkable progress both in curtailing public deficits and debt and in implementing structural changes and privatization programmes. At the same time, many researchers claim that austere fiscal measures and drastic private wage cuts have resulted in a deep recession in the Greek economy. This is why Greece emerges as the major source of economic and political instability in Europe. Many market analysts are thus quite certain that Greece will not be able to honour its obligations on time. They believe that default is so imminent that the Greek government must seriously examine the possibility of leaving the Eurozone and adopting drachma. To deal with these crucial issues, we will first determine whether the Greek public debt is sustainable.

Most of the data used in this paper are from the Eurostat Statistics Database (AMECO Database) and the database of OECD (OECD.Stat Extracts) and cover the period 1980-2009. A system of equations was estimated and a number of simulations was carried out to examine the effects of some macroeconomic factors on public debt. Finally, we made some scenarios concerning the public debt sustainability.

2. LITERATURE REVIEW

The issue of public debt sustainability has been at the center of the international research interest for the last 30 years. According to Blanchard (1990), focusing on debt sustainability may be due to the fact that the public debt has been climbing up in many OECD countries from 1980 onwards. The literature on public

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debt sustainability is very extensive dating back to classical authors like Hume, Smith and Ricardo, who discussed public debt mainly in terms of its general effects on the economy. Keynes (1923) claimed that when a government should run deficits in recessions, they should be offset by surpluses during expansions, in an attempt to avoid an escalation of the public debt. Domar (1944) also claimed that constant government borrowing results in a rising public debt which can be serviced by higher taxes. But, the continuous imposition of new taxes leads to recession and debt default. Blanchard, Chouraqui, Hagemann and Sartor (1990) supported this view by mentioning that the fiscal policy is sustainable when public debt does not increase constantly and the government is not obliged to increase taxes or decrease spending, in order to service debt and avoid debt repudiation. Buiter (1985) stated that the public debt is sustainable only if the government keeps the ratio of the net worth of the public sector to output at its current level. This presupposes that the present value of future primary surpluses must equal the current level of public debt. Focerrada (2005), in an attempt to interpret Mexico's 1982 and 1994-95 crises, claimed that the development of the capital and money markets, in collaboration with the banking system, could contribute to the financial development in general. Then, the government having the flexibility to borrow in the domestic market will depend less on international markets where interest rates may be higher. The government can then service its debt more easily since domestic financing overcomes to some extent the public debt sustainability problem.

Easterly *et al.* (1994) supported the view that the government must not allow large-scale increases in public debt due to the risk of default. Carlin and Soskise (2005) argued that the public debt can be sustainable when it is used for investment purposes and not for financing consumers' needs. Public investment expenditure give rise to externalities which enhance the competitiveness of domestic economy, broaden the tax base and increase tax revenues. As a result, public debt can be serviced more easily. Papadopoulos and Sidiropoulos (1999) claimed that current government liabilities must be offset by future fiscal surpluses to make the debt sustainable. If the government goes on borrowing without implementing development measures, the public debt may become unsustainable. Frenkel and Razin (1996) claimed that, if bankruptcy is to be avoided, policymakers must adopt fiscal consolidation programmes, through raising taxes

and cutting government expenditures. Introducing strict fiscal measures, however, may disrupt social cohesion and cause political instability.

The standard methodology in examining the fiscal sustainability problem is a univariate approach that focuses on the stationarity property of the stock of debt. For instance, Hamilton and Flavin (1986), based on a present-value framework, claimed that the stationarity of the discounted debt would indicate debt sustainability in a present-value framework. Furthermore, Davig (2005) used a markov-switching approach to model the two states of collapsing and expanding discounted debt. He showed that expanding discounted debt may not harm directly fiscal sustainability. An alternative method of assessment of fiscal sustainability is a multivariate approach that examines the long-run relationship between revenue and expenditure. Following a cointegration analysis, government expenditure (including interest payments) and total revenue should not diverge from each other in the long-run. If they diverge, fiscal sustainability may not be feasible. Trehan and Walsh (1988) showed that, if real revenue, real spending, and real debt have unit roots, stationarity of interest deficit (i.e. net deficit including interest payments minus primary deficit) is sufficient for debt sustainability. Based on this approach Haug (1991), Smith and Zin (1991), Trehan and Walsh (1991), Kremers (1988, 1989) and Bravo and Silvestre (2002) supported the view that the necessary condition for deficit sustainability is that revenue and expenditure (including interest payments) be cointegrated of order one, $I(1)$. Hakkio and Rush (1991) using data from 1950 through 1988, found out that U.S. debt was not sustainable. Afonso (2005) also used cointegration tests to examine fiscal sustainability in European Union countries. He found out that for the majority of the European Union countries, the fiscal policy may have led to an unsustainable debt situation. Lastly, some empirical studies [Quintos (1995), Tanner and Liu (1994), Ahmed and Rogers (1995), Martin (2000), Afonso *et al.* (2011), Cipollini *et al.* (2009) and Rico and Carrion-I-Silvestre (2011)] focused on the role of structural shifts, such as political changes or unusual events I (i.e. wars), in influencing public debt sustainability. Cipollini *et al.* (2009), for instance, showed that fiscal authorities may curtail government expenditure in order to reduce real per capita deficit when it reaches a certain threshold.

Deepening debt crisis and escalating fiscal imbalances nowadays, in conjunction with low growth rates in the euro area have shifted interest to the

government debt sustainability problem. Lejour, Lukkezen and Veenendaal (2010) examined the sustainability of debt in selected European Monetary Union (EMU) countries (Germany, France, Italy, Spain, Netherlands, Belgium, Ireland, Greece and Portugal) using a stochastic sustainability model and employing OECD projections until 2019. They simulated the path of government debt as a percentage of GDP and found its expected value. They included a confidence interval for each member-state conditional on deficit reduction scenarios and the behaviour of other EMU member-states. They showed that the budget deficits in all selected EMU countries (except Belgium) will rise and the public debt will become unsustainable, if governments are reluctant to adopt fiscal adjustment programs, given the social cost of population ageing by the end of the projection period. Even when population ageing is not taken into account, fiscal consolidation measures are required for nearly all EMU countries. However, debt unsustainability in Ireland, Greece and Spain could be a more serious problem than in the rest of the EMU countries, so that a more restrictive fiscal adjustment programme must be adopted by these three countries.

Curtasu (2011) investigated the evolution of the public debt in the European Union for the period 1970-2012. She found out that there are only a few countries (Denmark, Finland, the Netherlands and Sweden) which are not running any default risk. Their ratio of public debt to GDP is generally lower than the 60% threshold imposed by the Maastricht Treaty and their primary surplus is large enough to stabilize their public debt (except for the Netherlands). However, other countries, such as France, Ireland, Italy, Portugal, Spain and the UK, which have high debt-GDP ratios and primary deficits (or low surpluses), seem to face difficulties in servicing their debt. Lastly, Greece is an overindebted country with low competitiveness and unable to service its debt. Caporale (1995) using a method first developed by West (1987) detected speculative bubbles in financial markets. She examined whether the government budget is intertemporally balanced in a number of European Community countries. Her results showed that countries, like Italy, Germany, Denmark and Greece, are not intertemporally solvent.

Empirical investigation has also dealt with the issue of the sustainability of the Intertemporal Budget Constraint (IBC). IBC requires that fiscal policies satisfy the present value borrowing constraint: the present value of outlays (current and future) must equal the

present value of revenues (current and future). These empirical tests have been based on public debt unit root tests, cointegration tests between government revenue and expenditure [see Quintos (1995)] and fiscal reaction functions [Bohn (2007)]. Afonso (2005) claimed that most of the euro area countries run an unsustainability risk. However, Arghyrou and Luintel (2007), who employed threshold revenue-expenditure models, found that Greece, Italy, Ireland and the Netherlands are fiscally sustainable. Legrenzi and Milas (2011), assessing the fiscal sustainability of Greece, Ireland, Italy, Portugal and Spain, provided evidence of fiscal unsustainability when debt gets “too high” relative to a threshold. This threshold is not necessarily fixed but varies, depending on the level of debt relative to its recent history and/or on the occurrence of a financial crisis. According to their estimates, the above debt-to-GDP threshold level is higher than 87% for Greece and Italy, so that these countries may default more easily when a financial crisis occurs. This fact may result in contagion effects on other Eurozone countries. Fincke and Greiner (2011) supported the view that Greece and possibly Italy are fiscally unsustainable in the context of a model of time-varying coefficients.

De Grauwe (2011) attempted to examine the nature of sovereign debt when a country is a member of a monetary union (Spain) and when it is not (U.K.). He claimed that the members of a monetary union have no control of both their money supply and their exchange rate policy, which could possibly be used as deterrents to a possible default. Any other country might avoid default by using monetary and exchange rate policy measures to reduce the market pressure on its debt.

The conventional policy measures for facing debt sustainability problems seem to be inefficient as several members of the Eurozone run already the danger of default. The debt crisis has shown that, apart from eliminating medium-term risks to debt sustainability, short-term policy measures to reduce fiscal imbalances are also required. In the long-run, however, debt sustainability cannot be attained without restoring the debt-to-GDP ratio to the level of 60% of GDP through well designed and implemented growth policy measures.

3. THE CASE OF GREECE

World economic community has recently shifted its interest to the debt crisis in Greece as the public debt is considered to be unsustainable, fiscal deficits cannot

be curtailed and the possibility of default is quite high. A recent analysis conducted by the Troika (Greece: Preliminary Debt Sustainability Analysis, confidential report, 15 February 2012) suggested that Greece will need additional write-offs to lower its debts to 120% of GDP by 2020. In the Troika's baseline scenario based on current policy assumptions, Greece is expected to lower its debt to 129% of GDP by 2020, well above the 120% target. The Troika report suggested that a restructuring of the Greek debt held by the European Central Bank and the Eurozone central banks would reduce the country's debt-to-GDP ratio by 9 percentage points, thus facilitating the implementation of the 120% target. However, the sensitivity analysis shown in the report concluded that the Greek debt could reach 160% of GDP in 2020, if the recession turns out to be more severe than assumed in the basic scenario, and if structural reforms are not carried out at the proper speed. Moreover, the Troika contended that it is difficult to carry out the kind of adjustments which the Greek economy requires without an initial increase in the debt-to-GDP ratio. Reduced levels of this ratio are expected insofar as structural reforms and internal devaluation will start stimulating the domestic economy. Debt sustainability is strongly dependent on the assumptions of privatisations, growth and primary surpluses. The Troika warned that if the Greek primary surplus does not rise above 2.5% of GDP, from -1% in 2012, debt would be on an ever-increasing trajectory. If revenues from privatisations were €10 billion instead of €46 billion by 2020, the Greek debt would reach 148% of GDP. If the growth rate was permanently higher than 1%, debt would fall to 116% of GDP by 2020, but if it was permanently lower, debt would rise to 143%. Because the main financing source of Greece will be the European Financial Stabilization Fund (EFSF) and the ESM, a rise in the borrowing costs by 100 bps would lead the Greek debt to 135% of GDP in 2020.

Another recent analysis of the Greek sovereign debt crisis came from Alogoskoufis (2012). He claimed that the Greek public debt can be sustainable if Greece abides by a long-term fiscal discipline program achieving a sufficiently high primary surplus, which would initially stabilize the debt to GDP ratio. This depends on the initial debt to GDP ratio, but it also depends crucially on the growth rate of GDP relative to the interest rate. Fiscal adjustment must be implemented immediately by changing the tax system. Policymakers must lower business taxation and property taxes and establish a much simpler income tax system for households relying more on

consumption taxes, such as VAT and excises. This is because consumption in Greece exceeds the productive potential. The most efficient way to reduce primary deficit as a percentage of GDP is to increase the growth rate to an extent sufficient to exceed the real interest rate.

Baumann *et al.* (2012) took into account three key scenarios in order to make some predictions for the sustainability of the Greek public debt: fiscal discipline, growth rate and the average refinancing costs. They claimed that the current aid package is available until 2014, as the country is expected to return to the capital markets in 2015. Then, the Greek government may issue short dated bonds since its credibility will not have been restored. The growth rate may not be sufficiently high and the debt to GDP ratio may not have fallen enough to convince the markets to lend on a long-run basis. In their opinion, Greece may need a third rescue package, delaying its return to the capital markets for a few years. This could depend on the progress of fiscal adjustment, of the recovery process and of the interest burden on the budget.

Cline (2011) wondered whether the Agreement of October 2011 between the Greek government and Troika can promote the sustainability of the Greek public debt. He argued that the Greek public debt would become sustainable if the Greek government could achieve a high primary surplus of 6.4% of GDP in the period 2016-2020. Darvas, Pisani-Ferry, and Sapir (2011) claimed that the ratio of public debt to GDP can approach the level of 60% if 30% of the debt could be written-off. However, this requires a primary surplus at 8.4% from 2015 onwards.

4. MODEL

The model to be developed in the present section was based on a number of assumptions and took into account the relative theoretical background in public debt sustainability we developed our model.

To start with, the change of primary deficit, $Def_{p,t}$, was assumed to be equal to the difference between primary expenditures and tax revenues, that is

$$Def_{p,t} = G_t^D - T_t, G_t^D > T_t \quad (1)$$

The net deficit, Def , which includes interest payments, was given by the following equation:

$$Def_t = rD_{t-1} + Def_{p,t} = G_t^D - T_t + rD_{t-1} \quad (2)$$

Public debt in period t was given by the following equation:

$$D_t = D_{t-1} + Def_t = D_{t-1} + rD_{t-1} + Def_{p,t} = D_{t-1} + rD_{t-1} + G_t^p - T_t = (1+r)D_{t-1} + G_t^p - T_t \quad (3)$$

According to Blanchard, Amighini, Giavazzi (2010), equation (3) divided by GDP (Y) was transformed as follows:

$$\begin{aligned} \frac{D_t}{Y_t} &= (1+r) \frac{D_{t-1}}{Y_t} + \frac{G_t^p - T_t}{Y_t} = \\ &= (1+r) \frac{D_{t-1}}{Y_t} \frac{Y_{t-1}}{Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} = \Leftrightarrow \\ &= (1+r) \frac{D_{t-1}}{Y_{t-1}} \frac{Y_{t-1}}{Y_t} + \frac{G_t^p - T_t}{Y_t} \end{aligned} \quad (4)$$

Since $\frac{Y_{t-1}}{Y_t} = \frac{1}{1+g}$, where g is the growth rate, (4) took the form

$$\frac{D_t}{Y_t} = \frac{(1+r) D_{t-1}}{1+g Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} \quad (5)$$

Due to the fact that the real interest rate (r) and the growth rate are small decimal numbers,

$\frac{(1+r)}{1+g}$ can be expanded in series as

$$\frac{(1+r)}{1+g} \approx 1+r-g \quad (6)$$

Replacing (6) in (5) we got

$$\begin{aligned} \frac{D_t}{Y_t} &= (1+r-g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} = \\ &= \frac{D_{t-1}}{Y_{t-1}} + (r-g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} \Leftrightarrow \end{aligned}$$

After properly manipulating the last relationship, we got

$$\frac{D_t}{Y_t} - \frac{D_{t-1}}{Y_{t-1}} = (r-g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} \Leftrightarrow$$

or

$$\Delta\left(\frac{D}{Y}\right)_t = (r-g) \frac{D_{t-1}}{Y_{t-1}} + \frac{G_t^p - T_t}{Y_t} \quad (7)$$

Equation (7) indicates that the change in public debt to GDP ratio depends on: 1) the difference between the real interest rate and the growth rate multiplied by the previous year's public debt to GDP ratio and 2) the primary deficit to GDP ratio.

- With $r > g$ and primary deficits ($G_t^p - T_t > 0$), the ratio of public debt to GDP increases ($\Delta\left(\frac{D}{Y}\right) > 0$).
- With $g > r$ and primary surpluses ($G_t^p - T_t < 0$), the ratio of public debt to GDP decreases ($\Delta\left(\frac{D}{Y}\right) < 0$).
- With $g > r$ and primary deficits ($G_t^p - T_t > 0$), changes in public debt to GDP ratio are indeterminate.

The determinants of $\Delta\left(\frac{D}{Y}\right)$ in identity (7) (real interest

rate, growth rate, the ratio of public debt to GDP and the ratio of primary deficit to GDP), are possibly influenced by a number of other macroeconomic and fiscal factors. These factors, based on existing literature, are described below:

1) The Equation for Growth Rate

$$g_t = \beta_1 + \beta_2 TREND + \beta_3 p_t + \beta_4 \frac{D}{Y_t} + \beta_5 \frac{EXB}{Y_t} + \beta_6 \frac{IP}{Y_t} + \beta_7 r_t + \varepsilon_t \quad (8)$$

where

$\frac{D}{Y}$: Public debt to GDP

$\frac{EXB}{Y}$: External balance to GDP

$\frac{IP}{Y}$: Interest payments to GDP

$TREND$: Time trend

2) The Equation for the Ratio of Public Debt to GDP

$$\frac{D_t}{Y_t} = \gamma_1 + \gamma_2 TREND + \gamma_3 g_t + \gamma_4 r_t + u_t \quad (9)$$

3) The Equation for the Ratio of the Primary Deficit to GDP

$$\frac{PRDef_t}{Y_t} = \delta_1 + \delta_2 TREND + \delta_3 g_t + \delta_4 p_t + \delta_5 \frac{PREXP}{Y_t} + \delta_6 \frac{TAX}{Y_t} + M_t \quad (10)$$

where

$\frac{PRDef}{Y}$: Primary Deficit to GDP

$\frac{PREXP}{Y}$: Primary Expenditure to GDP

$\frac{TAX}{Y}$: Tax Revenue to GDP

4) The Equation for the Real Interest Rate

$$r_t = \varepsilon_1 + \varepsilon_2 TREND + \varepsilon_3 g_t + \varepsilon_4 \frac{PRDef_t}{Y_t} + \varepsilon_5 \frac{D_t}{Y_t} + \varepsilon_6 \frac{M_t}{Y_t} + \varepsilon_7 p_t + \eta_t \quad (11)$$

where

$\frac{M}{Y}$: Money supply to GDP

5. RESULTS OF ARDL METHODOLOGY

To test for the existence of a linear long-run relationship between the regressors in equations (8)-(11) (cointegrated series), when the orders of

integration of the underlying variables are not known with certainty, we made use of the approach proposed by Pesaran, Shin and Smith (2001). The test is the standard Wald or F-statistic for testing the significance of the lag levels of the variables in the first difference regression. The involved regressions are error-correction forms of the augmented autoregressive distributed lag (ARDL) model in the variables of interest.

The results of applying the ARDL methodology to each of the above four equations are presented in Tables 1-4.

6. SYSTEM EQUATION

Having determined the appropriate ARDL model estimations we solved the system of the four previously defined equations (growth rate, public debt to GDP, primary deficit to GDP and real interest rate) by Two Stages Least Squares (2SLS). The results are presented in Table 5.

Growth rate (equation 1 in Table 5) is related negatively to inflation rate. Other studies with similar results are those of Elmendorf and Mankiw (1998),

Table 1: Long-Run Coefficients of the ARDL(1,0,0,1,0,0) Equation of Growth Rate

| The dependent variable is g | | | |
|---|--------------|-----------------|-----------------------|
| Period estimation 1981-2009 (29 observations) | | | |
| Explanatory variables | Coefficients | Standard errors | t statistic [p-value] |
| D/Y | -0.26 | 0.08 | -3.20[.00] |
| p | -0.54 | 0.15 | -3.55[.00] |
| r | 0.63 | 0.25 | 2.54[.02] |
| IP/Y | -0.14 | 0.39 | -.36[.72] |
| EXB/Y | -0.48 | 0.17 | -2.90[.00] |
| C | 0.20 | 0.06 | 3.36[.00] |
| TREND | 0.00 | 0.02 | 1.03[.31] |

Table 2: Long-Run Coefficients of the ARDL(1,1,0) Equation of the Ratio of Public Debt to GDP

| The dependent variable is D/Y | | | |
|---|--------------|-----------------|-----------------------|
| Period estimation 1981-2009 (29 observations) | | | |
| Explanatory variables | Coefficients | Standard errors | t statistic [p-value] |
| r | 2.44 | 0.48 | 5.06[.00] |
| g | -3.19 | 1.52 | -2.09[.04] |
| C | 0.60 | 0.05 | 8.60[.00] |
| TREND | 0.01 | 0.00 | 11.37[.00] |

Table 3: Long-Run Coefficients of the ARDL(1,1,0,0,1) Equation of the Ratio of Primary Deficit to GDP

| The dependent variable is PRDef/Y | | | |
|---|--------------|-----------------|-----------------------|
| Period estimation 1981-2009 (29 observations) | | | |
| Explanatory variables | Coefficients | Standard errors | t statistic [p-value] |
| p | -1.43 | 0.74 | -1.94[.06] |
| TAX/Y | -2.70 | 0.67 | -4.03[.00] |
| PREXP/Y | 0.48 | 0.14 | 3.48[.00] |
| g | -0.19 | 0.61 | -.30[.76] |
| C | 0.96 | 0.32 | 3.00[.00] |
| TREND | -0.31 | 0.00 | -0.08[.93] |

Table 4: Long-Run Coefficients of the ARDL(1,1,1,0,0,1) Equation of Real Interest Rate

| The dependent variable is r | | | |
|---|--------------|-----------------|-----------------------|
| Period estimation 1981-2009 (29 observations) | | | |
| Explanatory variables | Coefficients | Standard errors | t statistic [p-value] |
| g | 1.17 | 0.37 | 3.16[.00] |
| p | 0.80 | 0.23 | 3.41[.00] |
| D/Y | 0.31 | 0.06 | 5.02[.00] |
| PRDef/Y | 0.14 | 0.13 | 1.03[.31] |
| M/Y | 0.32 | 0.25 | 1.29[.21] |
| C | -0.34 | 0.07 | -4.62[.00] |
| TREND | 0.00 | 0.00 | -0.44[.67] |

Checherita and Rother (2010) and Choong, Lau, Khim-Sen and Pua (2010). Furthermore, the ratio of external balance to GDP influences negatively the growth rate. Studies finding the same negative relationship are those of Abbas (2005), Checherita and Rother (2010) and Sachs and Warner (1995).

The ratio of primary deficit to GDP (equation 2 in Table 5) is influenced negatively by the ratio of the tax revenues to GDP. Studies which give similar results are those of Schmidt-Hebbel and Servén (1994), Clarida and Prendergast (1999) and Auerbach (2003). A positive influence is traced out for the ratio of primary expenditure to GDP and this influence is verified by previous studies, such as those of Koptis and Symansky (1998), Afonso (1990), Barro (1995, 1997), Lucas and Stockey (1983), King (1990) and Chari, Christiano and Kehoe (1994).

The ratio of public debt to GDP (equation 3 in Table 5) is related positively to the long-run real interest rate, as already has been shown by Kwack and Leipziger (1988), Cline (1983), Kwack (1988), Weintraub (1983),

Karagol (2002), World Bank (2005), Bandiera (2008) and Cunningham (1993).

Finally, the real interest rate (equation 4 in Table 5) is influenced positively by the ratio of the public debt to GDP. A positive relationship has also been found by Bernheim (1989), Cebula and Koch (1989), Kitchen (2002), Miller and Russek (1996) and Engen and Hubbard (2004). An insignificant relationship has been found by Seater (1993). Our econometrical estimates point to a positive relationship between the real interest rate and the inflation rate [see, also, Barro and Sala-i-Martin (1990), Barro (1991), Elmendorf and Mankiw (1999), Evans and Marshall (2002), Calomiris, Engen, Hassett and Hubbard (2003)], in contrast to the findings of Summers (1983), Huizinga and Mishkin (1984, 1986) and Barsky (1987) which supported an insignificant relation.

7. SIMULATION RESULTS

The coefficient estimates of the systems of equations (8)-(11), in conjunction with the identity (7),

Table 5: Results of System Equation

| SYSTEM EQUATION | | | |
|---|---------------------|---|------------------------------|
| Period estimation 1980-2009 (30 observations) Methodology 2SLS | | | |
| EQUATION 1: $g=C(1)+C(2)*@TREND+C(3)*D/Y+C(4)*p+ C(5)*r+ C(6)*IP/Y+C(7)*EXB/Y$ | | | |
| Explanatory variables | Coefficients | Standard errors | T statistic [p-value] |
| The dependent variable is g | | | |
| C | 0.164 | 0.070 | 2.34[0.02] |
| TREND | 0.000 | 0.003 | 0.26[0.8] |
| D/Y | -0.213 | 0.126 | -1.68[0.09] |
| p | -0.654 | 0.186 | -3.50[0.00] |
| r | 0.125 | 0.210 | 0.59[0.55] |
| IP/Y | 0.396 | 0.410 | 0.96[0.33] |
| EXB/Y | -0.560 | 0.199 | -2.81[0.00] |
| R ² = 0.54 Standard error = 0.017 | | Adjusted R ² = 0.415 DW Statistic = 1.835 | |
| EQUATION 2: $PRDEF/Y=C(8)+C(9)*@TREND+ C(10)*p+C(11)*TAX/Y+ C(12)*PREXP/Y+C(13)*g$ | | | |
| The dependent variable is PRDEF/Y | | | |
| C | 0.404 | 0.099 | 4.09[0.00] |
| TREND | 0.005 | 0.002 | 2.52[0.01] |
| p | -0.103 | 0.231 | -0.44[0.65] |
| TAX/Y | -1.664 | 0.254 | -6.56[0.00] |
| PREXP/Y | 0.381 | 0.098 | 3.88[0.00] |
| g | 0.067 | 0.233 | 0.29[0.77] |
| R ² = 0.805 Standard error = 0.021 | | Adjusted R ² = 0.763 DW Statistic = 0.838 | |
| EQUATION 3: $D/Y=C(14)+C(15)*@TREND+C(16)*r+C(17)*g$ | | | |
| The dependent variable is D/Y | | | |
| C | 0.376 | 0.024 | 15.35[0.00] |
| TREND | 0.027 | 0.002 | 15.23[0.00] |
| r | 2.256 | 0.357 | 6.32[0.00] |
| g | -0.057 | 0.624 | -0.09[0.92] |
| R ² = 0.951 Standard error = 0.063 | | Adjusted R ² = 0.945 DW statistic = 1.402 | |
| EQUATION 4: $r=C(18)+C(19)*@TREND+C(20)*g+C(21)*p+C(22)*D/Y+ C(23)*PRDEF/Y+C(24)*M/Y$ | | | |
| The dependent variable is r | | | |
| C | -0.289 | 0.076 | -3.80[0.00] |
| TREND | -0.005 | 0.005 | -0.92[0.36] |
| g | 0.272 | 0.262 | 1.03[0.30] |
| p | 0.513 | 0.263 | 1.95[0.05] |
| D/Y | 0.369 | 0.089 | 4.11[0.00] |
| PRDEF/Y | 0.173 | 0.155 | 1.11[0.27] |
| M/Y | 0.201 | 0.377 | 0.53[0.59] |
| R ² = 0.764 Standard error = 0.022 | | Adjusted R ² = 0.70 DW statistic = 2.254 | |

Table 6: Changes in $\Delta(\frac{D}{Y})$ and $\frac{D}{Y}$ After Reducing the Ratio of the Primary Deficit to GDP by 0.003

| | $\Delta(D/Y)$ | | D/Y | |
|--------------------|---------------|-------------------|---------|-------------------|
| | Average | Percentage change | Average | Percentage change |
| Baseline | 0.022 | | 0.492 | |
| Reduction by 0.003 | 0.018 | -18.18% | 0.449 | -8.74% |

are now used to assess changes in the ratio of debt to GDP after adjusting the fitted values of the determining factors on the basis of a number of predetermined scenarios.

7.1. The Effect of Changes in the Ratio of the Primary Deficit to GDP

Suppose that the fitted values of the ratio of primary deficit to GDP are reduced by 0.003 throughout the sample period, keeping constant the remaining variables. The estimates are presented in Table 6.

We note that the change in $\Delta(\frac{D}{Y})$ and the ratio of debt to GDP both decrease by 18.18% and by 8.74% respectively on the average after reducing the ratio of the primary deficit to GDP by 0.003, and this downward trend is in conformity with previous works [see Cipollini *et al.* (2009), Lejour, Lukkezen and Veenendaal (2010) and Curtasu (2011)].

7.2. The Effects of Changes in the Growth Rate

Let us now assume that the fitted values of the growth rate alone increase by 0.01 throughout the sample period. The estimates are shown in Table 7.

Table 7: Changes in $\Delta(\frac{D}{Y})$ and $\frac{D}{Y}$ After the Increase in the Growth Rate by 0.01

| | $\Delta(D/Y)$ | | D/Y | |
|------------------|---------------|-------------------|---------|-------------------|
| | Average | Percentage change | Average | Percentage change |
| Baseline | 0.022 | | 0.492 | |
| Increase by 0.01 | 0.014 | -36.36% | 0.400 | -18.7% |

Table 8: Changes in $\Delta(\frac{D}{Y})$ and $\frac{D}{Y}$ After an Increase in Real Interest Rate by 0.01

| | $\Delta(D/Y)$ | | D/Y | |
|------------------|---------------|-------------------|---------|-------------------|
| | Average | Percentage change | Average | Percentage change |
| Baseline | 0.022 | | 0.492 | |
| Increase by 0.01 | 0.030 | 36.36% | 0.584 | 18.7% |

We note that an one percent increase in the growth rate, decreases both $\Delta(\frac{D}{Y})$ by 36,36% and the ratio of debt to GDP by 18.7% on the average. This downward trend is supported by other studies [see, for example, Papadopoulos και Sidiropoulos (1999)].

7.3. The Effects of Changes in the Real Interest Rate

Estimates of the change in $\Delta(\frac{D}{Y})$ and $\frac{D}{Y}$ when the real interest rate increases by 0.01 throughout the sample period are presented in Table 8.

As shown in Table 8, an one percent increase in the real interest rate, increases both $\Delta(\frac{D}{Y})$ by 36.36% and the ratio of debt to GDP by 18.7% on the average. For similar results see, for example, Focerrada (2005).

7.4. Change in the Ratio of the Primary Deficit to GDP in the Context of Static Simulation

The previous analysis was based on a series of dynamic simulations which result in significant deviations from the actual data. The results of a static simulation where the actual data for each year are

Table 9: Changes in $\Delta \frac{D}{Y}$ and $\frac{D}{Y}$ After Reducing the Primary Deficit by 0.003

| | $\Delta(D/Y)$ | | D/Y | |
|--------------------|---------------|-------------------|---------|-------------------|
| | Average | Percentage change | Average | Percentage change |
| Baseline | 0.015 | | 0.801 | |
| Reduction by 0.003 | 0.012 | -20% | 0.798 | -0.37% |

used as a basis for the estimation of $\Delta \frac{D}{Y}$ in the next period are presented in Table 9 for a change in the ratio of the primary deficit to GDP.

We note that a decrease in the fitted value of primary deficit by 0.003 each year, reduces both $\Delta \frac{D}{Y}$ by 20% and the ratio of debt to GDP by 0.37% on the average.

8. PUBLIC DEBT SUSTAINABILITY SCENARIOS

The evolution of the public debt towards (un)sustainability was examined by carrying out a number of numerical estimates based on identity (7). The determining factors of the change in the ratio of debt to GDP were given by a variety of values depending on scenarios that were chosen.

The basic assumption was that the ratio of public debt to GDP is predicted to reach 164% in December 2012 and must decline to 120% up to the end of 2020.

As the ratio of the public debt to GDP must be reduced by 44 percentage points, identity (7) was transformed as follows:

$$-0,44 = (r - g)1,64 - \text{PRSUR}/Y \quad (12)$$

where PRSUR: Primary surplus

As is evident from identity (7) an excessively high debt to GDP ratio can converge to a sustainable level only when the growth rate is higher than the real interest rate, $g > r$, and the budget shows up with primary surpluses.

Scenario 1: The annual real interest rate is 2% and the annual growth rate is 3% throughout the period 2013-2020. In this case, equation (12) took the following form:

$$-0,44 = (0,02 - 0,03)*1,64*8 - 8*\text{PRSUR}/Y \Leftrightarrow$$

$8*\text{PRSUR}/Y = 0,3088$ and $\text{PRSUR}/Y = 0,038$, that is an annual primary surplus of 3,8% is required to restore sustainability of the public debt in 2020.

Scenario 2: The annual real interest rate is 2% and the annual growth rate is 4% throughout the period 2013-2020. In this case:

$$-0,44 = (0,02 - 0,04)*1,64*8 - 8*\text{PRSUR}/Y \Leftrightarrow$$

$8*\text{PRSUR}/Y = 0,1776$ and $\text{PRSUR}/Y = 0,022$ that is an annual primary surplus 2,2% is necessary to make the public debt sustainable in 2020.

Scenario 3: The annual real interest rate is 2,5% and the annual growth rate is 3% throughout the period 2013-2020. The required primary surplus was estimated at:

$$-0,44 = (0,025 - 0,03)*1,64*8 - 8*\text{PRSUR}/Y \Leftrightarrow$$

$8*\text{PRSUR}/Y = 0,3744$ and $\text{PRSUR}/Y = 0,047$ that is an annual primary surplus of 4,7% is necessary to achieve public debt sustainability.

Following a similar process but with a predetermined set of primary surpluses, we estimated the excess of the growth rate over the real interest rate for a successful debt sustainability policy. The results are present in Table 10.

Table 10:

| Scenario | Annual primary surplus to GDP, 2013-2020 | Required g-r |
|----------|--|--------------|
| 1 | 0,01 | 0,024 |
| 2 | 0,02 | 0,021 |
| 3 | 0,03 | 0,015 |
| 4 | 0,04 | 0,009 |

The Greek government has assumed the responsibility to privatize public enterprises and to utilize for commercial purposes a portion of the real

estate of the public sector. The privatization-utilization process is expected to end up with an amount of €50 billion which will be used to retire part of the public debt. A more realistic assumption would reduce this amount to €30 billion (15% of GDP) and would lower the ratio of debt to GDP to 150%, i.e. 30 percentage points above the target of 120%. In this case, the numerical representation of (7) is:

$$-0,30 = (r - g)1,64 - \text{PRSUR}/Y \quad (13)$$

By assigning predetermined sets of values to the growth rate and the real interest rate and by following the same process as above, we estimated the ratio of primary surplus to GDP which is required to obtain debt sustainability. The results are shown in Table 11.

Table 11:

| Scenario | r | g | Required PRSUR/Y |
|----------|-------|------|------------------|
| 1 | 0,02 | 0,03 | 0,021 |
| 2 | 0,02 | 0,04 | 0,004 |
| 3 | 0,025 | 0,03 | 0,029 |

Similarly, with a predetermined set of values for the ratio of the primary surplus to GDP, the required excess of the growth rate over the interest rate to obtain debt sustainability is shown in Table 12.

Table 12:

| Scenario | Annual primary surplus to GDP, 2013-2020 | Required g-r |
|----------|--|--------------|
| 1 | 0,01 | 0,016 |
| 2 | 0,02 | 0,0106 |
| 3 | 0,03 | 0,0045 |
| 4 | 0,04 | 0,0015 |

As become evident from the inspection of the above scenarios, debt sustainability in Greece can be restored only by achieving large primary surpluses and high interest rates, something which sounds exceptionally difficult in an economic environment with deep recession, inefficient public sector and low private-sector productivity. This explains why IMF officials insist on a second-round haircut of the Greek public debt. This haircut may take various forms. One of them is to transfer the amount of €50 billion (25% of GDP) for the re-capitalization of the commercial banks from the Greek debt account to the EFSF or ESM. In this case, the debt to GDP ratio would be further curtailed to 125%, i.e. 5 percentage points above the

target of 120% and debt sustainability would be much easier to be restored by the end of 2020.

8. SUMMARY

In the present paper, an attempt was made to quantify the effects of the main determinants of the public debt on debt sustainability in Greece. Simulations under alternative scenarios have shown that, given the political-economic conditions prevailing in Greece, it would be extremely difficult to restore debt sustainability by means of large primary surpluses and high growth rates. It is only the implementation of the ambitious privatization program and additional measures of indirect haircut that could help overcoming the debt problem and ensure fiscal-balance conditions in the long-run. A study which agrees with this conclusion is that of the Troika (2012). As it has already been mentioned, the Troika contended that the debt sustainability is strongly dependent on the assumptions of privatisations, growth and primary surpluses. Furthermore, the Troika suggested that Greece will need additional write-offs to lower its debts to 120% of GDP by 2020.

Even though the above policy measures to restore debt sustainability are common in all relevant studies, the scenarios used by each of them are different. The basic scenario of the present study was based on the assumptions of a 2% growth rate, an amount of €30 billion from privatizations and a 0.4% primary surplus to bring debt back to 120% of GDP by 2020. In contrast,

- (1) Troika (2012) postulated an amount of €10 billion from privatisations and a 2.5% primary surplus to lower the debt to GDP ratio to 148%.
- (2) Korliras and Monogios (2012) assumed an annual growth rate of 1.65%, an extension of fiscal adjustment beyond 2013 and up to 2016, a reduction of the interest rate from 4% to 3.5% and transfer of the amount of €45 billion for the recapitalization on the Greek Banks from the official Greek debt account to the EFSF/ESM. Under these assumptions, the debt to GDP ratio was estimated to become sustainable.

The policy implications of curtailing the debt to GDP ratio to the sustainable level of 120% by any of the aforementioned scenarios are the following:

- (1) Primary surpluses can be ensured by reducing wages, pensions, social transfer payments and redundant expenditures.

- (2) Revenues can be increased by curtailing tax evasion and carrying out the privatisations program.
- (3) Competitiveness of the Greek economy can be improved by adopting structural reforms, such as deregulation of the product market (i.e. eliminating oligopolistic conditions and abolishing licences for the establishment and expansion of enterprises) and deregulation of the labour market (i.e. less restrictive rules in employees' dismissals, reduction of the social security cost of both employees and employers, flexibility in working-hours agreements).
- (4) Structural reforms in the public sector, to eliminate corruption and bureaucracy, to introduce information systems, to improve judicature, to reduce the excessive number of civil servants etc.

All these measures are certain to result in deterioration in the living standard of the population, but they are necessary to get Greece out of the present debt crisis.

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