High public debt in the euro area: still a fact

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Summary

In this paper, we investigate the issues regarding the stabilization of public debt and its decrease down to 60 per cent of GDP for selected European Union countries using the primary balance derived from the public debt dynamic model as a leading indicator. We find that there is a high probability of stabilizing public debt at its 2014 level conditional on achieving an increased GDP growth rate . In addition, results indicate that it would take at least 10 years for many of the analyzed countries to decrease their public debt ratio to 60 per cent of GDP. We also draw conclusions on what really matters for fiscal sustainability and on implications for national and European fiscal policies.

Key Words: Fiscal policy, primary balance, public debt, fiscal sustainability, European Union

JEL Classification: E62, H62, H63

I.Introduction

With the creation of the single European currency, the use of macroeconomic policy tools became very limited for the member states. The monetary and exchange rate policy instruments disappeared from the arsenal of national authorities, who were limited to the use of fiscal policy when dealing with asymmetric shocks and guidance to their own national preferences (De Grauwe, 2009).

As the Eurozone is not an optimal currency area and in the absence of adjustment mechanisms that could replace the use of the nominal exchange rate in response to specific shocks (e.g. a strengthening of the EU budget) national fiscal policy has gained particular relevance (Barbosa and Alves, 2011). However, the possibility of negative spillovers across the EU , arising from the lax budgetary behavior of some members, has raised the need to maintain a strong fiscal discipline and for broad policy coordination.

These two aspects were highlighted in the Maastricht Treaty, but the attention was devoted mainly to the first, through the Stability and Growth Pact (SGP), in its 1997 and 2005 versions, which imposed tight restrictions on budget deficits and their consequences in terms of the public debt to GDP ratio (Alves and Afonso, 2007). The attention was essentially focused on the deficit side and less on the debt one, although the sustainability of public accounts should mainly derive from this component (Pisani-Ferry, 2005). Despite these fiscal rules, a relevant number of countries successively exceeded the limits imposed by the SGP, with the situation getting worse in recent years due to the financial and economic crisis.

In this context, the most recent times showed renewed attention to the issue of what is essential for fiscal sustainability. The sovereign debt crisis led to the conclusion that markets can assess the risk specific to each country, even when the debt securities are denominated in the same currency, contrary to what some admitted in the 1990s (Buiter, Corsetti and Roubini, 1993). Thus the current situation in the euro area implies an increased attention to the long-term sustainability of public debt and its implications for fiscal policy. Recent developments at the European level on fiscal surveillance mechanisms and on the strengthening of the coordination of fiscal policies – in particular the regulations contained in the so-called "6-pack" and "2 pack" (European Commission, 2013) – go in that direction.

The present article draws upon the above context, as we analyze the behavior of a number of euro area countries with high debt to GDP ratios. The aim of the study is thus to address the

following questions: 1) whether these economies have confronted public debt issues over the last decades; 2) whether the current fiscal policy can achieve public debt sustainability in the long run; 3) whether EU governments are able to stabilize the public debt to GDP ratio, and 4) whether EU governments can reduce the public debt to 60 per cent of GDP.

The remainder of the paper is structured as follows: section 2 presents stylized facts on key fiscal indicators revealing the indebtedness of a set of selected euro area countries; section 3 describes the theoretical background on fiscal sustainability when governments aim at stabilizing public debt; section 4 jointly addresses questions 2) and 3) for the selected countries; section 5 gives possible scenarios on reducing the public debt-to-GDP ratio to 60 per cent; section 6 discusses the influence of declining interest rates on stabilizing or reducing public debt; in section 7, we make some final remarks on what conditions or factors may truly be relevant to ensure budget sustainability and stability in the euro area and we draw policy implications for national and European fiscal policies.

II. Some stylized facts on selected euro area countries' public debt

There is a rich recent literature showing that the public debt in the advanced economies has considerably increased over the last decade (e.g. Scott, 2010; Reinhart and Rogoff, 2011) which can be by various factors such as: the stimulus spending and lower revenues of the past forty years which contributed to large primary deficits (e.g.Gosh, Kim, Mendoza, Ostry and Qureshi, 2011); the growth of social public spending (e.g. Adema, Fron and Ladaique, 2011); pro-cyclical fiscal policy (e.g. Afonso, Agnello, Furceri and Sousa, 2009); governments' tolerance on running Ponzi schemes for financing budgetary deficits (e.g. Buiter, 2004).

Using annual data ranging from 1970 to 2014 (where available) provided by Ameco for selected euro area countries, we calculate the average values of the key variables such as: public debt-to-GDP ratio (b), public debt growth rate, implicit interest rate on public debt (i)[♣], GDP growth rate (y) and primary balance (p), in order to have a better picture of the countries' indebtedness. The countries under investigation are Austria, Belgium, Germany,

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[♣] We choose to use the implicit interest rate on the public debt as a proxy for the government bonds interest rate considering the large time frame in our analysis. The implicit interest rate is calculated according to the European System of Accounts description as interest of the current year divided by the value of gross public debt of preceding.

Greece, Italy, France and Portugal. We used the debt ratio as sole criterion for our selection. We found for the selected countries that the average public debt-to-GDP ratio after the Maastricht Treaty (MT) is higher than the average ratio registered for the entire period, higher than the average before MT and also exceeds 60 per cent of GDP. Hence we presume that these countries are most likely to confront solvency difficulties emerging from high public debt.

Analyzing the public debt-to-GDP ratio reported in Table 1, one can notice that for all the countries under investigation the conditions got worse after the Maastricht Treaty. The indebtedness ratio grew compared to the public debt-to-GDP ratio before MT and is larger than the limit imposed by the Treaty.

[Insert Table 1 here]

Greece has the largest standard deviation of the indebtedness ratio, indicating important difficulties in stabilizing the public debt. We also observed that the maximum for all the analyzed countries was registered after introducing MT while the minimum values are reported for the early years of the considered period. To be more specific, the largest public debt-to-GDP ratios were recorded after the financial crisis hit worldwide.

Studying the dynamic of public debt-to-GDP ratio over the period of 1970-2014, one can notice that the largest increase was reported for Greece, followed by Portugal, France and Italy (see Table 2).

[Insert Table 2 here]

Focusing on the crisis years, figures show that the annual increase of the public debt after the crisis exceeded the annual growth rate observed for the entire period. In the case of Greece, the annual increase of indebtedness ratio was of 8.5 p.p. per year which is almost 3 times larger than the biggest increase recorded in 45 years before the crisis. Second highest growth of public debt-to-GDP ratio is accounted for Portugal: in this case the growth of public debt in the last 8 years after the crisis represents 50 per cent of the total growth for the entire period. We also found that in the case of France, Greece and Portugal public debt-to-GDP ratio increased over the last years after the crisis more than 1 standard deviation reported for the entire period under analysis. Hence, we believe that the selected countries confront some solvency difficulties which could jeopardize fiscal sustainability in the long run. Therefore, public debt stabilization should be a priority and, in effect, EU governments have already

undertaken tight fiscal consolidation actions in order to limit the growing deficits and have focused mainly of fiscal sustainability issues.

We also observe that the GDP growth rate decreased where the interest rate on public debt is larger than the growth rate, even if the interest rate decreased after 1993. Additionally, the public debt growth rate was already larger than the GDP growth rate and it remained so after the introduction of the Maastricht Treaty rules (except for Belgium) (see Table 3).

[Insert Table 3 here]

The interest rate - economic growth rate differential (γ) was negative in most of the cases before 1993 and turned to positive values thereafter, hence indicating that the cost of public debt was higher than the GDP growth rate. The accepted general convention is that of a negative differential for running sustainable fiscal policy in the long run. Escolano (2010) writes also about a "modified golden rule" implying a positive gap that holds for most mature economies presumed to be around their long-term dynamic steady state, which also is the case of the selected countries.

Nevertheless, fulfilling the solvency constraint implies governments to run primary surpluses. We observed that the primary balance for most of the countries improved (excepting France and Portugal) compared to its historical average or to the average registered after introducing the Maastricht Treaty. There is a rich literature (e.g. Barro, 1979; Bohn, 1998) studying fiscal reaction function and indicating that fiscal policy should respond immediately and positively to shocks to public debt. This implies governments to run primary surpluses as public debt increases, in order to achieve fiscal sustainability in the long run. Looking at the covariance between public debt and primary balance (see Table 4) we observe negative changes in the two variables for France, Greece and Portugal, and positive changes in the case of Belgium, Austria, Germany and Italy.

[Insert Table 4 here]

However, our results show that the relationship is statistically significant only for Belgium, Austria, Italy and France. For France, the primary balance didn't adjust adequately to the increase of the indebtedness ratio whilst for Austria, Belgium and Italy the data suggest better adjustment of fiscal policy. Nevertheless, the arising question here is whether this increase/decrease in the primary surplus/deficit was large enough to service governments' payment obligations and to achieve the solvency constraint.

Summing up, our results show the increase of public debt-to-GDP ratio over the last decade despite the constraints and limits imposed by the Maastricht Treaty. The cost of public debt is higher than the economic growth rate and even if this 'modified golden rule' holds for the advanced and stable economies, then governments should run primary surpluses to achieve the solvency constraint and the fiscal sustainability over the long run. Thus we found a weak correlation between public debt and primary balance indicating difficulties in adjusting the primary balance to shocks on public debt. Given this overview of key variables, we assert that the selected countries have confronted public debt issues. Therefore, studying the possibility to stabilize public debt is a reasonable and relevant next step.

III. Fiscal sustainability and stabilization of public debt: theoretical background

Generally speaking, fiscal sustainability means a 'good management' of the government revenues. But the literature on that topic is still far from being at a consensus when defining this concept. For instance, Blanchard (1990), and Blanchard, Chouraqui, Hageman, and Sartor (1990) indicated that fiscal policy is sustainable when (i) public debt does not explode, nor governments are forced to increase taxes, decrease spending, monetize fiscal deficit or repudiate public debt, or (ii) public debt, as ratio of GDP, converges to its initial level.

Zee (1987), Horne (1991), Buiter (1995), Chalk and Hemming (2000), de Castro Fernandez and Hernandez de Cos (2000) made the concept much more operational with respect to the solvency constraint. They asserted that fiscal policy is sustainable when the government has the ability to generate primary surpluses to meet its future payment obligations.

Being solvent is a necessary but not a sufficient condition for a government to run a sustainable fiscal policy (Horne, 1991). Hence, Artis (2000) and Croce and Juan-Ramon (2003) suggested that being fiscally sustainable means a solvent government reimbursing public debt in the long run under unchanged conditions of the current fiscal policy.

Derived from previous definitions the arithmetics of fiscal sustainability starts with the public debt dynamic equation. At time *t*, government finances the primary deficit (the difference between primary expenditures, G_t, and government revenues, R_t) and pays interest on the accumulated stock of public debt ($i \cdot B_{t-1}$), by issuing new public debt (difference between B_t and B_{t-1}), which gives:

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

where i is the nominal interest rate on public debt.

Considering expectations at time t (E_t), equation (1) turns into the intertemporal budget constraint (IBC) described by equation (2):

$$B_t = -E_t \sum_{k=0}^{\infty} (1+i)^{-(1+k)} (G_{t+k} - R_{t+k}) + \lim_{k\to\infty} E_t (1+i)^{-(1+k)} B_{t+k+1} \tag{2}$$

The IBC describes the solvency constraint and states that the public debt at time t should equal the discounted value of the expected primary surplus plus the limit value of the discounted public debt at a terminal time. Fiscal policy is sustainable when government also fulfils the transversality condition given by equation (3):

$$\lim_{k\to\infty} E_t (1+i)^{-(1+k)} B_{t+k+1} = 0 \tag{3}$$

Rewriting equation (1) when expressing the variables as ratios-to-GDP, we obtain:

$$\frac{B_t}{Y_t} = \frac{G_t}{Y_t} - \frac{R_t}{Y_t} + i \cdot \frac{B_{t-1}}{Y_{t-1}} \cdot \frac{Y_{t-1}}{Y_t} + \frac{B_{t-1}}{Y_{t-1}} \cdot \frac{Y_{t-1}}{Y_t} \tag{4}$$

Considering the nominal GDP growth rate as: $y = \frac{Y_t}{Y_{t-1}}$, then equation (4) becomes:

$$b_t = p_t + \frac{1+i}{1+y} \cdot b_{t-1} \tag{5}$$

where p_t is the primary deficit (G_t-R_t).

Now, derived from equation (5) and following Barnhill and Kopits (2003), the solvency constraint is described by:

$$b_{t-1} = \Sigma_{j=0}^{\infty} \left(\frac{1+y}{1+i}\right)^j \cdot p_{t+j} \tag{6}$$

The conventionally accepted condition for fiscal sustainability when government aims at stabilizing public debt to a certain debt to GDP ratio which is held constant over time and is represented by equation (7):

$$p^* \geq \frac{i-y}{1+y} \cdot b \tag{7}$$

where: *i, y* and *b* are constant and we use the following notation: $\gamma = \frac{i-y}{1+y}$ and p^* is the primary balance that stabilizes public debt.

When government plans to keep the public debt growth rate down to zero, then fiscal policy is said to be sustainable when the primary surplus equals γb. This is consistent with the primary gap suggested by Blanchard (1990) for studying fiscal sustainability and thereafter used in various papers (see for instance Pasinetti, 1998).

IV. The success of stabilizing public debt in selected EU countries

We plan to study fiscal sustainability by estimating the probability that governments are able to achieve a stabilizing primary surplus derived from equation (7). In that sense, we use the *z-scores* for p^*. We standardize the calculated primary balance based on the equation: $z = \frac{p^*-\mu}{\sigma}$, where μ is the mean and σ is the standard deviation for the data representing the current primary balance. Considering that the success of stabilizing public debt implies current primary balance equal or larger than the stabilizing primary balance, we calculate the probability $P(Z \geq z)$ to analyze which are the chances for fiscal policy to be sustainable in the long run. For our calculations we use the dataset representing primary balance ranging from 1970-2014. We make some projections for 2014 and 2015 assuming that governments aim at stabilizing public debt. For estimation, we use the expected data for economic growth rate, interest rate and public debt-to-GDP ratio for these two years. The results are reported in Table 5.

[Insert Table 5 here]

We observe that Belgium has the highest probability to stabilize public debt in 2014, followed by Germany and Austria. For the rest of the selected countries the probability is very low. In Greece's case, the calculation showed the lowest probability of stabilizing public debt this year. We recalculate the stabilizing primary balance considering the GDP growth rate that is expected for 2015. We notice that only Germany and Greece expect their public debt to decline considerably for the next year. We found that if higher economic growth rate could be achieved, this would lead to considerable increase in the probability to stabilize public debt for Greece and also for France while Portugal has the lowest probability.

Through discretionary fiscal policy the required primary balance that stabilizes public debt can be achieved, leading to fiscal consolidation. In that sense, if we look at the data for the expected primary balance (p) for 2014 and 2015 and compare them to the required primary balance (p^*) and observe the adjustments that should be further undertaken by governments (see Table 6).

[Insert Table 6 here]

For Germany, Austria and Italy the data show that governments can stabilize public debt, if aiming at this goal for both years because the expected primary balance for 2014 and also for 2015 is larger than the required one. Belgium and Portugal could stabilize debt in 2015 while France still needs adjustments in that sense. Additionally, results indicate for the case of Greece that stabilization could be achieved for the next year but this requires large fiscal adjustments.

Stabilizing public debt implies governments to achieve constant required primary balance for several years. Hence, the issues here are, on one hand, if the governments are still willing to take more adjustment actions by cutting spending and/or by increasing taxes, and on the other hand, if more fiscal consolidation will affect economic growth. Pisani-Ferry (2012), analyzing the measures introduced by the EU and the US to recover from the economic recession, revealed that the US government chose to stimulate the private sector by increasing households' consumption, hence postponing fiscal consolidation while the EU countries were more focused on fiscal consolidation. He indicated that these distinctive strategies resulted on better economic performance in the US. He also argued that Europe has to learn to reconcile tight fiscal policy and supply side economics. In addition, Fatas and Mihov (2009) and Afonso, Agnello, Furceri and Sousa (2009) showed that over the period 1970-2007, fiscal policy in the euro area has been mildly pro-cyclical, and the adoption of the common currency and the constraints imposed by the SGP have not had a large impact on the cyclical behavior of the structural balance. Moreover, in the last 30 years, fiscal position has not significantly changed for most of the European countries. Recent work (e.g. Vegh and Vuletin, 2014) also documents that pro-cyclical fiscal policy implemented within eurozone during the past crisis contributed to making the current crisis more socially costly in terms of unemployment and social conflict. Additionally, Chari and Blair Henry (2014) that tight fiscal consolidation undertaken by some European governments slowed down the economic recovery compared to other countries carrying out a different fiscal adjustment strategy ().

Hence, we believe that in order to achieve fiscal sustainability in the long run, EU governments should make significant efforts to foster economic growth rather than more fiscal policy adjustments.

V.The soundness of reducing public debt in EU countries

The second part of our study concerns the possibility of reducing the public debt to GDP ratio from the current level to that of 60 per cent, as required by the European fiscal rules. Balassone and Franco (2000) asserted that achieving the criteria of 3 and 60 per cent GDP imposed by the Maastricht Treaty for public deficit and public debt allows for fiscal discipline and flexibility and excludes any bias from an unsustainable fiscal policy in the long run. Following this view, we evaluate the soundness of this scenario and what efforts would it imply for governments. For this purpose, we calculate the required primary balance that hits a given debt ratio (p^{**}) derived from equations (1) to (5) and following Escolano (2010):

$$p^{**} = \frac{\gamma}{(1+\gamma)^{-T}}\left[(1+\gamma)^{-T} \cdot b_T - b_0\right]$$

(8)

where:

p^{**}: the required primary balance that hits a given debt ratio; b_T and b_0 are the target and the initial debt ratio; T: the periods when target debt ratio is achieved.

Using the dataset described in Section 4 of this paper, we analyze the possibility of reducing the public debt from the stabilizing ratio in 2014 towards 60 per cent of GDP. To this end we estimate the primary balance that hits the given debt ratio and the probability of fulfillment considering that interest rate is kept constant at 2014 levels and varying the GDP growth rate. The *z-scores* and the probability of achieving the required primary balance are calculated as presented in previous section. The results are reported in Table 7.

[Insert Table 7 here]

We found that there is an increased probability for Austria and Germany to reduce their public debt ratio to 60 per cent of GDP in 10 years if they reach a GDP growth rate equal to the average level before the introduction of the Maastricht Treaty. For Greece, Italy and Portugal, it seems unlikely that they will manage to hit the debt ratio even if the GDP growth rate increased to the level registered before the MT. For France, only achieving a growth rate as before introducing MT would significantly increase the probability to reduce public debt in 10 years, however, just to a little higher than 50 per cent.

Analyzing if expanding the time horizon would lead to an increase in the probability of hitting 60 per cent, we found that growing GDP still has the largest influence in reducing the debt ratio (see Figure 1 and Figure 2):

[Insert Figure 1 and 2 here]

Adjusting the fiscal balance in order to achieve the required primary surplus for reducing the public debt ratio to 60 per cent of GDP implies considerable efforts in cutting spending or increasing taxes. The question arising here concerns the reasonability of such efforts because these also generate additional costs mostly related to social indicators.

The governments had to cope with various challenges generated by the financial crisis and economic recession, which in turn helped to create large budget deficits and to increase public debt. Thus governments' agenda is very tight and the choice of priority goals very difficult to establish. Dealing with the public finance issues indicates the need of large fiscal adjustments usually consisting of cutting government spending and/or increasing the revenues which can induce a pro-cyclical effect within economy. Helping economy to recover from the recession implies contrary fiscal measures based on increasing government expenditures and/or decreasing taxation. Our findings suggest more focus on stimulating the economy in order to place it on a growth path which in the end can prove benefic for public debt.

VI.Would declining interest rates make a difference?

In 2006 the European Commission asserted that high-debt countries are more vulnerable to negative interest rate/growth rate shocks through the increased interest burden. We have already showed that fostering economic growth would increase the probability to stabilize and reduce public debt-to-GDP ratio due to negative gap when keeping interest rate unchanged. One alternative approach in achieving a negative gap for maintaining public debt on a stable path is by borrowing money at lower cost, hence benefiting of reduced interest rates.

Under various scenarios of declining the interest rates, we find that the probability of stabilizing public debt at the ratio of 2014 would increase significantly for Belgium, Germany and Austria when reducing the interest rate by 0.5 p.p while for rest of the analyzed countries the decrease should be larger. The results are similar also when aiming at reducing the public debt to GDP ratio at 60 per cent in 10 years. ForGreece, France, Italy and Portugal the decline in the interest rate should of 2 p.p. in order to reduce the debt ratio (see Figure 3 and 4).

[Insert Figure 3 and 4 here]

Interest rates on public debt are likely to be exogenous and are not entirely under the control of governments. For the past four years issues concerning the interest rates on public debt have becoming more sensitive. Investors' expectations of sovereign bonds yields include a higher premium due to the default risk and it is more difficult for the peripheral governments to issue bonds at pre-2008 interest rates.

VII.Concluding remarks

In this paper we study the stabilization of public debt in a dynamic model and the alternative scenario of reducing its ratio down to 60 per cent of GDP for a selected number of e euro area highly indebted countries, We started by looking at some descriptive statistics that clearly show how fiscal situation has generally worsened after the Maastricht Treaty when compared to the average of before the Treaty. Public debt-to-GDP ratios have increased and that, together with a positive differential between the interest rate on public debt and the GDP growth rate, has determined the need to go for strong primary balances. we then showed that such primary balances have been far from those necessary to stabilize the public debt to GDP ratio in almost all of the analyzed countries. We also showed that for almost all of those countries, decreasing the public debt to GDP ratio to the required value of the SGP would be feasible over a period of 10 years only with a substantial increase of GDP growth rate, in some of the cases meaning a rate that would have to be higher than the one registered before the introduction of the Maastricht Treaty.

Our results point out that, for the moment, the most convenient scenario for these economies (and the other European ones being in a similar situation) would be to aim at stabilizing the current public debt to GDP ratio, taking into account that there is an increased probability of achieving a stabilizing primary balance.

Taking together all the presented results, five aspects seem to deserve particular attention when dealing with the important issue of fiscal sustainability within the eurozone: (i) although important, the simple stabilization of public debt to GDP ratio seems to be a rather difficult task for almost all the high indebted countries of the eurozone; (ii) the european fiscal rules, more concerned with the level of public deficits (SGP and Fiscal Compact), seem not to be sufficient to guarantee fiscal sustainability; (iii) a greater preoccupation with economic growth seems to be a necessary condition for success in obtaining fiscal sustainability – with an higher GDP growth rate, the stabilization of public debt comes easier,

and this should be stressed to political leaders in Europe; (iv) a joint action of the euro zone countries, such as the emission of eurobonds (or other form of joint debt securities), seems to be a good idea − for several countries, it would help to reduce the debt to GDP ratio to a lower level, which, together with a lower nominal interest rate required by investors, would easy the path to fiscal sustainability; (v) recent action taken by the European Central Bank, with the program for purchasing public debt securities, seems to be on the right way to ease the task for national governments, as interest rates turned to be lower.

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Table 1:   Descriptive statistics on public debt-to-GDP ratio

Country	Public debt (per cent GDP)			Max	Min	St.dev.
	All	Before	After			
Belgium	97.4	91.1	104.7	134.1	54.3	25.1
Germany	48.3	32.1	66.8	82.4	17.7	19.9
Greece	76.2	39.7	118.0	175.2	15.7	47.4
France	51.0	29.7	68.2	96.2	19.8	22.5
Italy	90.7	69.9	114.5	132.2	37.2	28.0
Austria	52.0	38.8	67.1	73.8	16.7	18.4
Portugal	57.1	40.5	73.8	124.3	13.5	26.6

Notes: (1) All: 1970-2014; Before Maastricht Treaty: 1970-1993 (if available); After Maastricht Treaty:1994-2014. (2) annual averages for public debt-to-GDP ratio calculated using annual data available from Ameco.

Table 2:   Public debt-to-GDP dynamic

Indicator	Belgium	Germany	Greece	France	Italy	Austria	Portugal
σ	25.1	19.9	47.4	22.5	28.0	18.4	26.6
Δ	42.1	60.9	155.2	96.2	94.9	55.2	110.8
δ	18.1	13.4	67.8	32.0	28.9	13.5	56.0
N	45	45	45	38	45	45	42
n	8	8	8	8	8	8	8
Δ /N	0.9	1.4	3.4	2.5	2.1	1.2	2.6
δ /n	2.3	1.7	8.5	4.0	3.6	1.7	7.0
δ / Δ	0.4	0.2	0.4	0.3	0.3	0.2	0.5

Notes: (1) σ: the standard deviation. (2) Δ: the difference between public debt-to-GDP ratio in 2014 and in 1970. (3) δ: the difference between public debt-to-GDP ratio in 2014 and in 2007. (4) *N:* number of years over the period 1970-2014. (5) *n:* number of years over the period 2007-2014.

Table 3: The average values of key variables

Country	Public debt growth rate			Implicit interest rate on public debt			Primary balance (per cent GDP)			GDP growth rate		
	All	Before	After	All	Before	After	All	Before	After	All	Before	After
Belgium	7.8	13.0	2.2	5.6	8.9	5.1	1.5	-0.1	3.3	6.6	9.2	3.6
Germany	10.2	14.8	5.1	5.1	8.2	4.8	0.4	0.1	0.6	6.8	10.6	2.4
Greece	12.6	17.9	6.7	7.7	15.8	6.6	-0.8	-2.8	-0.2	6.7	9.4	3.7
France	9.8	13.6	6.8	6.2	8.4	4.7	-0.8	-0.5	-1.0	6.4	9.2	3.1
Italy	9.8	15.2	3.8	7.7	11.9	5.9	0.8	-2.1	2.7	6.6	9.8	3.0
Austria	11.1	17.1	4.5	5.1	7.4	4.8	0.2	-0.3	0.6	7.5	11.1	3.5
Portugal	12.9	18.2	8.1	6.9	16.0	5.6	-1.1	-0.7	-1.5	7.5	10.9	3.6

Notes: (1) All: 1970-2014; Before Maastricht Treaty: 1970-1993 (if available); AMT:1994-2014. (2) annual averages for the key variables calculated using annual data available from Ameco. (3) implicit interest rate on public debt calculated as current interest payments on public debt derived by public debt from previous year. (4) implicit interest rate on public debt, public debt growth rate and GDP growth rate are in nominal terms.

Table 4:   The covariance between public debt and primary balance

Country	Covariance	t-stat	p-value
Belgium	41.20	3.86	0.00
Germany	7.85	1.24	0.14
Austria	6.81	2.48	0.01
Italy	48.47	7.44	0.00
Greece	-10.11	-0.44	0.65
France	-13.89	-2.83	0.00
Portugal	-2.19	-0.23	0.81

Table 5:   The *z-scores* and the probability of stabilizing public debt in 2014 and 2015

	I		g		b		p*		*z-score*		*prob.*	
Country	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015	2014	2015
Belgium	3.27	3.11	2.87	2.98	102.10	101.01	0.40	0.13	-0.32	-0.41	0.63	0.66
Germany	2.90	2.79	3.51	3.73	78.64	74.08	-0.46	-0.67	-0.45	-0.57	0.67	0.71
Greece	2.54	3.03	0.25	3.31	175.05	170.94	3.99	-0.46	1.28	0.09	0.10	0.46
France	2.72	2.74	2.80	3.22	96.23	95.98	-0.07	-0.45	0.46	0.21	0.32	0.42
Italy	4.31	4.29	2.27	2.63	132.18	133.14	2.63	2.15	0.60	0.44	0.28	0.33
Austria	3.64	3.65	3.46	3.56	73.68	73.54	0.13	0.06	-0.02	-0.07	0.51	0.53
Portugal	3.52	3.54	1.82	2.48	124.34	125.71	2.08	1.30	1.33	1.00	0.09	0.16

Table 6:   The fiscal adjustments for stabilizing public debt in 2013 and 2014

	p*		p		adj. (p*-p)	
Country	2013	2014	2013	2014	2013	2014
Belgium	0.40	0.13	0.00	0.53	0.40	-0.40
Germany	-0.46	-0.67	2.30	2.30	-2.76	-2.97
Greece	3.99	-0.46	1.80	4.07	2.19	-4.53
France	-0.07	-0.45	-1.75	-1.13	1.68	0.68
Italy	2.63	2.15	3.06	3.13	-0.42	-0.98
Austria	0.13	0.06	0.77	1.09	-0.64	-1.03
Portugal	2.08	1.30	0.29	1.84	1.79	-0.54

Table 7:   The *z-scores* and the probability of reducing public debt ratio in 10 years
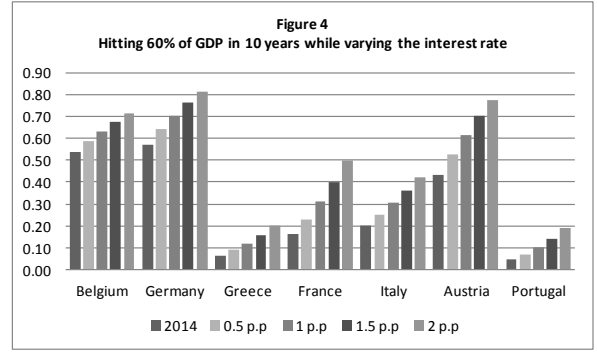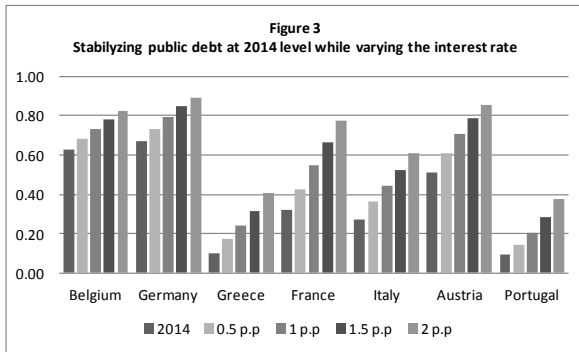
GDP growth rate	Belgium	Germany	Greece	France	Italy	Austria	Portugal
[1]	0.18	0.27	0.00	0.00	0.00	0.17	0.00
[2]	0.22	0.15	0.00	0.00	0.01	0.17	0.00
[3]	0.47	0.70	0.02	0.12	0.09	0.81	0.04
[4]	0.69	0.96	0.10	0.55	0.32	0.99	0.27

Notes: Scenarios [1]: the GDP growth rate at 2014 level; [2]: the GDP growth rate at the average value after introducing Maastricht Treaty; [3]: the GDP growth rate at the average value for the entire period; [4]: the GDP growth rate at the average value before introducing the Maastricht Treaty.

Figure 1
Probability of hitting 60% and time horizon

Figure 2
Probability of hitting 60% and GDP growth rate
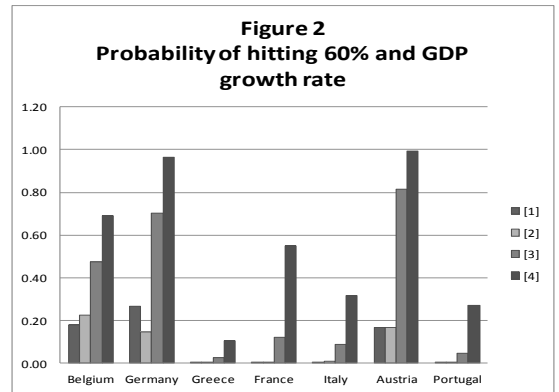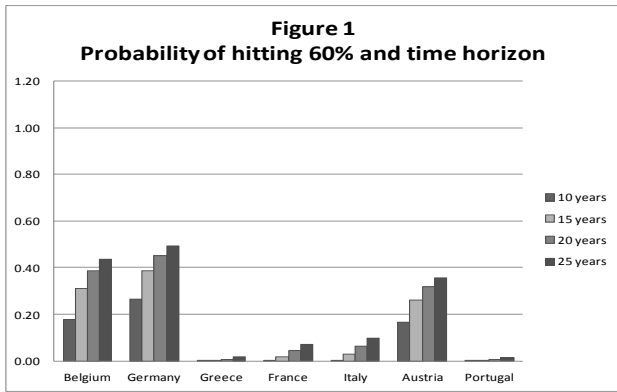
Note to Figure 1: we kept the interest rate on public debt and the GDP growth rate at the 2014 level and varied the time horizon.

Note to Figure 2: we kept the interest rate constant at the 2014 level and varied the GDP growth rate according to scenarios [1] to [4] from Table 7.

Figure 3
Stabilyzing public debt at 2014 level while varying the interest rate

Figure 4
Hitting 60% of GDP in 10 years while varying the interest rate

Note to Figure 3: we kept the GDP growth rate constant at 2014 level and declining the interest rate on public debt when stabilizing the ratio at 2014 level.

Note to Figure 4: we kept GDP growth rate constant at 2014 level and declining the interest rate on public debt when reducing the ratio at 60per cent of GDP in 10 years from 2014 level.