The Study of Public Debt. Which Are the Distinctions between the Emerging and Advanced Economies in the European Union?

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Abstract

The aim of our paper is to provide a comprehensive study of public debt in various aspects across the European Union,emphasizing the existing distinctions between the emerging and advanced economies in Europe. Using annual data ranging from 1995 to 2013 we develop investigation manifold. Firstly, we study the descriptive statistics of key variables affecting public debt dynamics. We found that the ex-communistcountries recorded lower public debt ratios, negative flow costs and primary deficits. By comparison, the advanced economies managed to run primary surpluses in order to balance larger public debt-to-GDP ratios and the positive flow cost. Secondly, using the accounting approach we analyzed the dynamics of public debt. The results indicated unstable dynamics for the cases of CzechRepublic, Latvia, Lithuania, Poland, Slovakia, Slovenia, Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain and the United Kingdom. Then, employing a logit model with fixed effects, we also showed that running primary deficits is more likely to increase the probability of having unstable dynamics of public debt. Thirdly, we examined the distribution of the flow cost and revealed that there is an increased probability of extreme values which, in the case of large debt ratios, might lead to high debt burdens for the European countries. We also found that the uncertainty of the future debt burden is driven by the variability of the real GDP growth rate.

Keywords*: public debt, flow cost, primary balance, sustainability, European Union*

JEL Codes: *E62, H62, H63*

1.Introduction

The financial crisis in 2007-2008, which turned into a sharp economic recession worldwide leading also to sovereign debt crises, brought into attention important public debt related aspects which seemed to have been disregarded by most of the governments lately.

There are authors who documented the considerable increase in public debt over the last decades (Scott 2010; Reinhart and Rogoff 2011) as a result of stimulus spending and lower revenues of the past forty years (Ghosh, Kim, Mendoza, Ostry and Qureshi 2013) and of the rise in social public spending (Adema, Fron and Ladaique 2011) which contributed to large deficits. Also, considering a certain loosening of the financial markets that led to lower interest rates for government bonds along with the economic boost in the late 90's and thereafter, governments felt more comfortable with borrowing more money in order to finance increasing deficits and debt.

There is clear evidence that public debt rose and, besides the well-known stated sources of its growth, we believe that government behavior had a significant contribution to the current situation. For instance, in 2004, Willem Buiter explained why policy makers prefer running Ponzi schemes and roll over the public debt instead of smoothly adjusting fiscal policy. The author argued that when there is no terminal date, or even if there is one but it is far in the future, there is an obvious temptation for a debtor to put off the day ofreckoning as long as possible and even after 200 years of deficits the debtor can always argue that it has all the rest of eternity to run the necessary primary surpluses. Much earlier, O'Connell and Zeldes (1988) demonstratedthat a Ponzi game eventually comes to an end when there are a finite number of agents. Then, even if the government would like to roll over its debt, it means that there is some individual that would have to hold government bonds at some infinite point in future. As a result, this individual would have to lower consumption, and therefore, to lower his welfare in order to hold government bonds. Attempting to run a Ponzi finance scheme will find that no rational individual is willing to hold government liabilities, and, therefore, it cannot roll over its debt in full in every period.

We strongly believe that this can explain well what happened in Greece recentlyor in other European peripheral countries whereinvestors became reluctant in buying more sovereign bonds due to poor economic conditions.Governments found it more difficult to borrow money in the financial markets. Thus, they were forced to take severe fiscal consolidation actionsin order to reduce or to keep tight the budgetary deficits and the public debt. The debt crisis in Europe and the fear of systemic contagion (Hurlin, Popescu and Turcu 2013) along with the solvency issues imperiling the fiscal sustainability in the long run made public debt a fervent debated topic nowadays.

Following the debt crisis in 2009, there is an increased interest in public debt issues. For instance, Aizenman and Pasricha (2010) investigated the distribution of the flow cost across OECD countries looking for fat tails. They suggested that extreme events are likely to occur and stressed out that future debt burden is likely to increase with the size of future debt. Turner and Spinelli (2011) examined what forces drove the unusual low differential over the last decade and found that there were a few factors (i.e. low inflation volatility, low policy rates) which are likely to be reversed in the future hence affecting the size of the flow cost. They also observed the narrowing of interest rate spreads on 10-years government bonds in the last two decades probably because indebted countries did not have the option to tackle fiscal problems through a lax monetary policy, so higher inflation, currency depreciation and default were thought unlikely. Reinhart, Reinhart and Rogoff (2012) analyzed the debt overhang episodes and found that they are associated with lower economic growth and that these effects are not driven by the real interest rates. Egert (2015) studied the negative nonlinear effects of large public debt on economic growth and found evidence for lower level of public debt between 20% and 60% of GDP.

The present article draws upon the above context as we analyze various public debt related aspects across the European Union (EU) countries. The contribution of our paper is manifold. Firstly, we examine several key variables affecting public debt dynamics. Secondly, we study the stability of debt dynamics. We also investigate which factors contribute to an increase in the probability of having

unstable dynamics. Thirdly, we investigate the distribution of the flow cost looking for extreme values and effects on the debt burden. Another important contribution is that we conduct our analysis for 27 EU countries[1] on annual data, ranging from 1995 to 2013, and we emphasize the existing distinctions between the advanced and the emerging economies in all the above mentioned aspects.

The European Union is a unique economic and political construction because it brings together countries with great diversity in their development and well-being and also with distinct social and historical backgrounds. The EU has a core, comprised of the 6 founder countries, which nowadays has been enlarged to form the euro area. Since 2004, EU has been extended to include the former communist countries from Central and Eastern Europe. EU accession and the increased opportunities for trade cooperation andforeign direct investments strengthened their transition to the marketeconomy. Hence, they became the fastestgrowing economies across Europe. But this process also made them particularly vulnerable to economic shocks (Zaidi and Rejniak 2010).

The transition from a centralized economy to the market economy involved massive intervention of governments for funding structural reforms that were implemented. They also benefited of important financial aid from international organizations such as the International Monetary Fund (IMF) and the World Bank (for more details, see Dabrowski, 1995). Therefore, we have reasons to believe that the Central and Eastern European countries might exhibit a more rapid increase in the public debt compared with the advanced economies in Europe. We expect our analysis to clearly point out some distinctions among the two groups of countries.

The reminder of the paper is structured as follows: section 2 presents the arithmetic of public debt dynamicsand discusses several possible situations emphasizing the role of the flow cost and of the primary balance in making the difference between stable and unstable dynamics towards the steady state. Section 3 gives details about the dataset used and the methodology employed in our analysis. Section 4 presents the major findings of our study. The last section consists of the main concluding remarks and policy recommendations. We conduct our investigation on a dataset consisting of 27 European Union countries, ranging over the period 1995-2013. We purposely selected the time frame since the Treaty of Maastricht (MT) came into force by introducing the budget deficit and public debt constraints which were supposed to foster sound and sustainable public finance across Europe.

2. Public debt dynamics

The dynamics of public debt can be easily described by the one period budget constraint:

$$B_t = B_{t-1} + i_{t-1} \cdot B_{t-1} + PD_t \qquad (1)$$

where B_{t-1} stands for nominal general government debt at the end of year $t-1$, i_{t-1} denotes the nominal interest rate paid on government debt and PD_t stands for the primary deficit at the end of year t which equals primary government expenditures less tax revenues.

When expressing the variables as ratio to GDP, we divide equation (1) by $P_t y_t$, where P_t and Y_t represent the GDP deflator and the real GDP. Denoting with small letters for ratios to GDP and with π_t the inflation rate and y_t the real GDP growth rate, equation (1) can be rewritten as:

$$b_t = b_{t-1} \cdot \frac{1}{(1+\pi_t)(1+y_t)} + b_{t-1} \cdot \frac{i_{t-1}}{(1+\pi_t)(1+y_t)} + pd_t \qquad (2)$$

[1]Croatia is not included in our analysis due to lack of sufficient data series for the newest member of the EU.

Applying Fisher's equation $(1+i_{t-1})=(1+\pi_t)(1+r_t)$, where r_t, is the real interest rate on public debt at time t, then the public debt-to-GDP ratio evolves according to:

$$b_t = \frac{1+r_t}{1+y_t} \cdot b_{t-1} + pd_t \tag{3}$$

We approximate $\frac{1+r_t}{1+y_t}$ by $(1+r_t-y_t)$ and equation (3) becomes:

$$b_t = (1+r_t-y_t) \cdot b_{t-1} + pd_t \tag{4}$$

Using (4), the change in public debt-to-GDP ratio equals:

$$\Delta b = (r_t - y_t) \cdot b_{t-1} + pd_t \tag{5}$$

Based on equation (5), the debt ratio will grow or shrink at the rate $(r_t - y_t)$[2] depending if the interest rate is higher or lower that the GDP growth rate and assuming a balanced primary budget. If the government runs a primary deficit/surplus then the public debt increases at a rate exceeding/less than $(r_t - y_t)$.

Considering a simple linear equation describing the dynamics of public debt: $b_k = \lambda \cdot b_{k-1} + c$ where λ is the slope, c is a constant and $k = 1, \dots, t$, we can discuss several possible trajectories of public debt.The *steady state* dynamics of public debt is equated by $b_k = b_{k-1}$ and implies $\Delta b=0$ while $c = 0$. We believe that steady state dynamics can be consistent with Blanchard, Chouraqui, Hagemann and Sartor (1990) view on fiscal sustainability that in the long run the debt ratio should converge back to its initial level. Recalling equation (4), one condition of maintaining public debt on the steady state trajectory would be that $r_t = y_t$ and that $pd_t = 0$ .There are two distinct situations of the dynamics towards the steady state: when $\lambda \leq 0$ the dynamic is said to be *stable* and when $\lambda > 0$, the dynamics is *unstable*. In the case of $r_t < y_t$, the public debt gradually approaches the steady state. Assuming that the initial fiscal position is unbalanced, $c \neq 0$, when $c > 0$, the convergence towards the steady state is slowed down. When, $c < 0$, the convergence speeds up. These distinct cases imply that when the rate of growth of public debt $(1 + r_t - y_t) < 1$ and whenthe initial fiscal position is a large primary deficit ($c>0$) then, reaching the steady state, would take more time and the steady state would beset up at a higherdebt ratio. This is consistent with Domar's assertion in 1944 that governments can finance the primary deficit infinitely as long as the interest rate is lower than the economic growth rate. On the contrary, 50 years later, Bartolini and Cottarelli (1994) argued that a stream of permanent deficits is not sustainable on a steady state and that the debt has to grow at a rate no greater than the GDP growth rate. If the initial fiscal position isa primary surplus ($c<0$) then reaching the steady state is faster and the steady state ratio is lower. However, after reaching the steady state and if $r_t < y_t$ public debt will continue its stable dynamics.

When $r_t > y_t$, the public debt ratio could deviate from the steady state, having an unstable dynamics. When λ is greater than 1 there are two possible outcomes: if $c > 0$ and large, then the deviation from the steady state is more sizeable; if $c < 0$ the divergence is smaller. This implies that when the implicit interest rate on public debt is greater that the GDP growth rate, then governments should run an initial primary surplus for keeping the debt ratio closer to the steady state. If the initial

[2]Following Aizenman and Pasricha (2010), we refer to the differential between the real interest rate on public debt and the real GDP growth rateas the *flow cost*and to the product between the flow cost and the public debt-to-GDP ratio as the *debt burden.*

fiscal position is a primary deficit, the public debt ratio will be placed on an unstable path. Escolano (2010) argued recently that a*modified golden rule*can hold because of the economic agents' preference for current versus future consumption. He also documented that for most mature economies, presumed to be around their long term dynamic steady state, empirical data showed that the interest rate was higher than the economic growth rate. However, there are many authors (e.g. Blanchard, Chouraqui, Hagemannand Sartor 1990; Cuddington 1997; Chalk and Hemming 2000) who reasoned that the debt ratio should be bounded and/or that the public debt growth rate should be less than the GDP growth rate when the flow cost is positive if governments wish to achieve fiscal sustainability in the long run. In 2006, the European Commission also warned that high-debt countries are more vulnerable to negative interest-rate/growth-rate shocks through the increased interest burden.

Considering an extended model which includes the composition of the public debt, equation (1) can be re-written as:

$$B_t^D + B_t^F = (B_{t-1}^D + B_{t-1}^F) + i_{t-1}^D B_{t-1}^D + i_{t-1}^F B_{t-1}^F + PD_t \quad (6)$$

where*D*denotes the government debt issued in national currency and *F* denotes the government debt issued in foreign currency.

When expressing variables as GDP ratios in national currency we divide equation (6) by *PtYt*and multiply the foreign debt with the nominal exchange rate, S_t. We assume that the public debt issued in year *t-1* at the rate of $S_{t-1}$is repaid in year *t* at the rate of S_t.Doing some algebra, we can re-write equation (6) as:

$$b_t^D + b_t^F = \frac{(1+i_{t-1}^D)}{(1+\pi_t)(1+y_t)} b_{t-1}^D + \frac{(1+i_{t-1}^F)(1+\epsilon_t)}{(1+\pi_t)(1+y_t)} b_{t-1}^F + pd_t \quad (7)$$

where small caps denotes GDP ratios and $\epsilon_t$is the percentage variation of the nominal exchange rate, $\frac{S_t}{S_{t-1}} - 1$.

Using the real interest rate on domestic debt, $r_t^D$and the real interest rate on foreign debt, r_t^F and making some linear approximations, we obtain equation (8):

$$b_t = b_{t-1} + (r_t^D - y_t) b_{t-1}^D + (r_t^F + \epsilon_t - y_t) b_{t-1}^F + pd_t \quad (8)$$

If we consider the real exchange rate, $RER_t=S_tP_t^*/P_t$, where P_t^* is the foreign price level, the real rate of depreciation, $\varepsilon_t=\epsilon_t+\pi_t^*-\pi_t$, where π_t^* is the foreign rate of inflation and π_t is the domestic rate of inflation,thenthe dynamic of public debt can be written as:

$$\Delta b_t = (r_t^D - y_t) b_{t-1}^D + [(r_t^F + \epsilon_t) + (\pi_t^* - \pi_t - y_t)] b_{t-1}^F + pd_t \quad (9)$$

Equation (9) suggests that the dynamic of public debt is influenced by several variables which include the interest rate on domestic government borrowings and on government bonds issued in foreign currencies, the composition of public debt, the real exchange rate and the differential between the foreign inflation rate and the domestic inflation rate. In this situation, various cases can be discussed when governments aim at converging towards the steady state of public debt ($b_t=b_{t-1}$), assuming a balanced primary budget ($pd_t=0$). Hence, in the case when governments decide to finance by issuing bonds in national currency, $b_{t-1}^F=0$, then the real GDP growth rate, y_t, should equal the interest rate on domestic bonds for public debt to converge towards the steady state, $y_t=r^D$. In the case when governments issue bonds in foreign currency and $b_{t-1}^D=0$, then, the real GDP growth rate, $y_t$should equal the interest rate on foreign- currency bonds and the depreciation of the national currency, $y_t=(r_t^F+\varepsilon_t)+(\pi_t^*-\pi_t)$. In this case,

governments could be confronted with an increased exposure to various risks which are beyond their control. In the case of a mixed composition of public debt, when $b_{t-1}^{D} \neq 0$ and $b_{t-1}^{F} \neq 0$ then keeping public debt on a stable dynamic implies that the differential between the interest rate on foreign-currency bonds and the interest rate on domestic-currency bonds should equal the differential between the foreign and domestic inflation rate less the real depreciation of national currency, $r_t^F - r_t^D = \pi_t^* - \pi_t - \varepsilon_t$, or that the composition of public debt is given by $b_{t-1}^{D}/b_{t-1}^{F} = [(y_t + \pi_t - \pi_t^*) - (r_t^F + \varepsilon_t)]/(r_t^D - y_t)$.

When the primary budget is unbalanced, $pd_t \neq 0$, then public debt convergence towards the steady state also depends on the sign of the primary balance. When governments run a primary deficit, $pd_t > 0$, the domestic-currency debt flow cost, $r_t^D - y_t$, and the foreign-currency debt flow cost, $r_t^F + \varepsilon_t + \pi_t^* - \pi_t - y_t$, should be negative. If the foreign-currency debt flow cost is also positive, then the domestic-currency debt flow cost should be negative to compensate the unstable deviations from the steady state. When governments run a primary surplus, the steady state can be reached even when the domestic-currency debt flow cost and the foreign-currency debt flow cost are positive, under the condition thatthe primary surplus islarger than the debt burdens: $-pd_t > (r_t^D - y_t) b_{t-1}^{D} + [(r_t^F + \varepsilon_t) + (\pi_t^* - \pi_t - y_t)] b_{t-1}^{F}$.

Aizenman and Pascricha (2010) documented that extreme events such as large positive flow costs are likely to occur, hence contributing to an increase in the debt burden. In these situations, if governments are not able to respond rapidly by adjusting the primary balance for achieving a surplus or at least to reduce the deficit, public debt is more likely to have an unstable trajectory. De Grauwe and Ji (2012) also suggested that investors are mispricing the sovereign bonds. The authors argued that after 2008, investors apply large risk premiums, even if they are disconnected with the underlying increase in the public debt-to-GDP ratios and they are the result of a negative market sentiment. A similar conclusion was reached by Schoder (2014) who stated that refinancing sovereign debt became costly for many of the European Monetary Union members. These findings indicate that the flow cost could exhibit large variations due to the rise of sovereign bond spreads which are subject to changes in the market sentiment which is beyond governments' control. Moreover, as Stoian and Alves (2012) emphasized with the creation of a single European currency the use of macroeconomic policy tools is limited to the use of fiscal policy for many of the member states and the monetary and exchange rate instruments are no longer available to them. Under these conditions, we can discuss about two distinct fiscal policy strategies for the purpose of maintaining the stable dynamics of public debt when flow costs are positive. One could be the consolidation of fiscal policy in order to achieve a primary surplus in the short run to compensate the positive debt burdens and to decrease the future public debt-to-GDP ratios. In this case, lowering economic growth could be foregone and could increase the debt burdens on medium term. The second would be running a primary deficit to foster economic growth and to turn the positive flow cost into a negative one. The side effect could be an increase in the instability of the public debt dynamics in the short run. The chosen strategy depends on the size of the flow cost and public debt-to-GDP ratio. In situations when the debt burdens are large, governments would probably choose fiscal consolidation to correct the dynamics of the public debt towards a steady state in the short run. In situations when the debt burden is small, governments might prefer postponing fiscal consolidation and fostering economic growth through primary deficits aiming at anindirect stabilization of the dynamics of the public debt.

For further analysis, we considera public debt dynamics model with the same implicit interest rate for both domestic and foreign-currency debt. Thus, we can rewrite equation (10) as:

$$\Delta b = (r_t - y_t) b_{t-1} + (\varepsilon_t + \pi_t^* - \pi_t) b_{t-1}^{F} + pd_t \qquad (10)$$

We refer to the differential $r_t - y_t$ as the total debt flow cost and we denote it with $\gamma$and to the differential $\varepsilon_t + \pi_t^* - \pi_t$ as the foreign-currency flow cost and we denote it with φ. We examine the public debt dynamics using equation (11):

$$\Delta b = \gamma b_{t-1} + \varphi b_{t-1}^{F} \qquad (11)$$

3. Dataset and methodology

We conduct our investigation on27 European Union countries. We divided the EU into two distinct groups: the emerging economies from Central and Eastern Europe represented by the former communist countries: Bulgaria, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia and the advanced economies represented by Austria, Belgium, Cyprus, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, Malta, Netherlands, Portugal, Spain, Sweden and United Kingdom. We expect to find distinct results for the two groups of countries. We purposely chose this time frame considering that MT has come into force since 1993 and all the EU economies have to meet the requirements imposed for the budgetary deficit and for the public debt. Our analysis develops threefold:

Firstly, using equations(10) and (11), we study the gross public debt-to-GDP ratio (b), the real GDP growth rate (y) calculated as percentage variation of the real GDP in 2010 market prices, the real interest rate on public debt (r) calculated as ratio of the interest payments at time t to the gross debt at time $t-1$less the domestic inflation rate, the real exchange rate (ε) calculated as variation of the real effective exchange rate index for 28 trading partners (EU members), the foreign inflationrate (π^*) calculated as variation of the harmonized index of consumer price for 28 EU countries and the domestic inflation rate (π) calculated as the variation of the national consumer price index. We also study the total debt flow cost (γ) and the foreign-debt flow cost (φ). The primary data is reported by Ameco and Eurostat. The purpose of this analysis is to find some stylized facts about the variables influencing public debt dynamics and to emphasize the existing distinctions for the two groups of countries.

Secondly, we investigate the public debt dynamics towards the steady state. For this purpose, using equation (5) we estimate the *stabilizing primary balance* which allows public debt to gradually reach the steady state and compare it with the actual primary balance to check for the deviations. We also calculate the *excess of the primary balance* in order to check the stability of public debt dynamics. We conduct this analysis on annual data ranging from 1996 to 2013. We also employ a binary model in order to explain whichvariables drive the unstable dynamics of public debt.

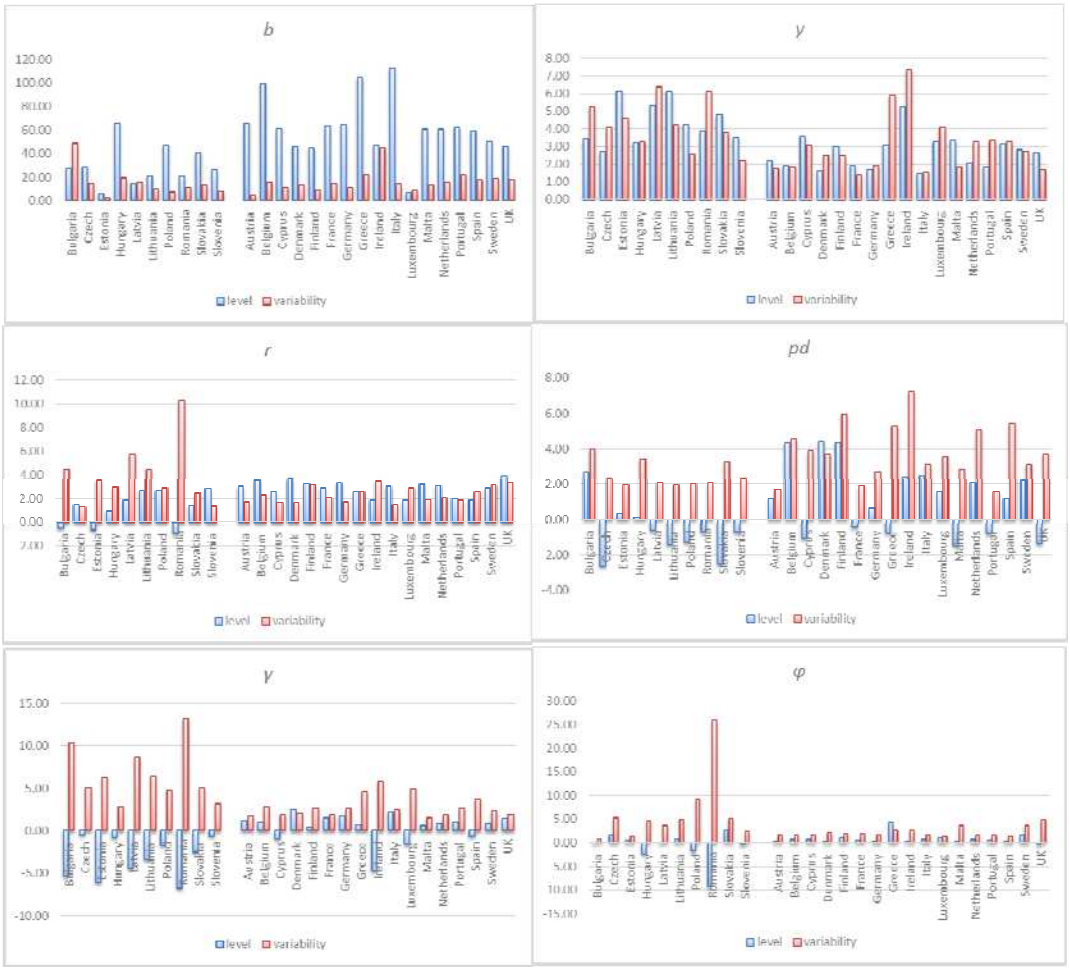
Thirdly, following Aizenman and Pasricha (2010) we investigate the distribution of the flow cost using historical data and looking for extreme values which are likely to generate shocks tothedebt burden.We also employed an OLS regression for a cross-section of 27 countries to examine the factors which drive the uncertainty of the future debt burden.

4.Results

4.1.Stylized facts

We study the size of the variables affecting the public debt dynamics using the median as a relevant statistic forthe reason of eliminating influence of large values. We also report the 1st ($q1$) and the 3rd ($q3$) quartile along with the minimum (min) and the maximum (max) values. For investigating the variability in the dataset, we calculate the distance between $q1$ and$q3$ and alsothedistancebetweenmin and max. The results are reported in Table 1 in the Appendix. Figure 1 also plots the level and the variability of the key variables.

Figure 1 The level and the variability of key variables affecting public debt dynamics



Note: the 'level' is represented by the median for each of the variables under investigation and the 'variability' is represented by q3-q1.

Analyzing the results, we found that the public debt-to-GDP ratio for the emerging countries in EU is much lower than for the advanced economies. Despite the transition to the market economy which required large government interventions, the situation can be explained considering that in the early 1990s many of the former communist countriesbenefited of debt relief. Buiter and Lago(2001)provided some examples in that sense. For instance, in 1994, Bulgaria reached a Brady reduction agreement of almost 30% of its initial external debt and also negotiated reschedule agreements with its bilateral creditors; in 1991, Poland was granted with one-third write-down of its debt owed to Paris club members and, in 1993, negotiated a similar debt write-down with its commercial creditors in the London club; Romania fully repaid its external debt to the Western creditors during the 1980s through a policy of consumption rationing and import contraction, while the Baltic countries were free of external debt at the time of their

independence. Hungary is the most indebted country across the emerging European economies, and in order to fully service its initial sizeable debt it implemented stabilization and adjustment policies.The median indicates that for many advanced economies, such as: Austria, Belgium, Cyprus, France, Germany, Greece, Italy and Portugal, the debt ratio is larger than 60% of GDP as imposed by Maastricht Treaty, whilst Hungary is the only emerging economy whose ratio exceeds this limit. The distance *q3-q1* indicates that Bulgaria has the highest variability of the debt ratio across EU. This evidence can be argued considering that Bulgaria scored the largest public debt-to-GDP ratio of 108% in 1997 when it decided to establish the currency board which induced a tighter fiscal discipline that led to a sharp decrease in the debt ratio. Ireland also has a large variability of the public debt-to-GDP ratio. Until 2007 the levels of public debt in Ireland were declining up to 25% of GDP. But, starting in 2008, the public debt soared again as a consequence of deep recession and the injection of public money into the Irish banking system during the next few years.

The real GDP growth rate is significantly higher in the former communist countries than in the advanced economies. The Central and Eastern European countries made considerable efforts to narrow the existing economic growthgap. One way of rapidly assessing this target was pushing up the domestic demand to increase the GDP growth rate. Nevertheless, this led to unstable economic growth indicated by large variability of the real GDP growth rates.

We also found that the real interest rate on public debt is lower in the emerging countries compared with the advanced economies.We explain this result by means of the higher domestic inflation rate registered by former communist countries in EU (see Table 1 in the Appendix, π^{*}-π). The lowestrate across Europe is observed for the case of Romania, as well as the highest variability. Analyzing the interest rate in nominal terms, we noticed that the rate in the emerging economies was on average by 2 p.p. higher than in the advanced ones. Economic instabilityevidenced by higher variability in the real GDP growth rate and in the domestic inflation rate, as well as political and legislative inconsistency, might prompt investors to be more reluctant when lendingformer communist governments, hence asking higher risk premiums for the sovereign bonds. In this sense, we also found that Romania recorded the greatest nominal interest rate on public debt, while Hungary and Poland, which are the most indebted countries among the emerging economies in the EU, had lower rates than Romania's.Lago (2011) argued that Hungary and Poland employed appropriate financial and fiscal policies in order to improve their credit ratings and also developed local currency markets for Treasury bills and bonds to help diversify government funding resources whereas in Romania's case most of its problems are a matter of illiquidity and confidence loss associated with unsound fiscal policies.

Examining the flow cost, the results indicate that thetotal debt flow cost,γ,has negative values for the emerging countries and positive values for most of the advanced economies, excepting Cyprus, Ireland, Luxembourg and Spain, whereas he foreign-currency debt flow cost, φ, is positive in the advanced economies, excepting the United Kingdom and negative for many Central and Eastern European countries.This suggeststhat the 'golden rule' of the public finance holds for many of the emerging economies, while for the advanced economies a 'modified golden rule' is applicable. We also noticed that the flow costs exhibit greater variability in the case of ex-communist countries. The results for the primary balance also indicate that over the analyzed period, most of the emerging economies run primary deficits and most of the advanced countries achieve primary surpluses. This evidence is explainable considering that we found negative flow costs for the Central and Eastern European countries and positive for the mature economies in the EU.

So far, from these comparisons we have learned that the former communist countries in EU reached lower indebtedness ratios, negative flow costs and primary deficits. On the contrary, the advanced economies had larger debt ratios, positive flow costs and primary surpluses. We believe that in order to run a stable dynamic of the public debt, Central and Eastern European governments should make efforts in achieving primary surpluses to compensate the possible changes in the flow cost due to sudden changes in the financial markets sentiment which may lead to higher interest rates on government bonds. For the advanced economies which have already been experiencing positive flow costs, reaching

substantial primary surpluses would be the key element of a stable dynamics. Thus, we believe that studying the dynamics of public debt will reveal more relevant insights.

4.2.Steady state and public debt dynamics

We can study public debt dynamics towards the steady state using the so called*accountingapproach*(Cuddington, 1997)described by equation (5), $\Delta b = (r_t - y_t) \cdot b_{t-1} + pd_t$, and setting up the condition of stabilizing the public debt, as: $\Delta b=0$. Thisimplies that $b_t=b_{t-1}$, which equates the *steady state*. Thus, we can estimate the *stabilizing primary balance*, p_t^*which assures the asymptotic convergence towards the steady state.

$$p_t^* = (r_t - y_t) b_{t-1} \tag{12}$$

There is a large debate in the existing literature concerning if the stabilization should be made at the level from the current year, b_t, or at the level from previous year, b_{t-1}.According to the theory of fiscal reaction function, for fiscal policy to be sustainable in the long run, hence assuring a stable dynamic of debt, government's response to shocks on public debt should be instantaneous. But, taking into account that the theory documents various lags (recognition, decision, implementation, and impact) between the time when the problem occurs and the time when policy responds, we may consider reasonable the decision to stabilize debt at the level from previous year.

Comparing the *stabilizing primary balance,* $p_t^*$with the actual primary balance, p_t, we state that whenever $p_t \geq p_t^*$, the debt ratio has a stable dynamics and otherwise. Additionally, we calculated the differences $(p_t - p_t^*)$ for each year, then we summed them for the entire period under investigation. We name this *theexcess of the primary balance (EP)* which is described by:

$$EP_k = \sum_{t=1}^{N} (p_t - p_t^*)_k \tag{13}$$

where, N is the number of observations and k is the corresponding country.

Thus, we state that when $EP \geq 0$, the debt dynamics is gradually converging towards the steady state, and when $EP<0$, thepublic debt has an unstable dynamics.

Figure 2 plots p_t^* and $p_t$for 27 EU countries over the period 1996-2013. We used a linear trend in order to capture the smooth movements on long-term and a polynomial trend to show the short-term fluctuations for both variables under investigation. The results for *EP* are also reported in Table 2 in the Appendix.

Figure 2 The stabilizing and the actual primary balance for EU countries, 1996-2013

Note: red dots depict the actual primary balance, p_t; blue dots depict the stabilizing primary balance, p_t^*; straight/curved red line shows the long/short-term movement/fluctuations of p_t; straight/curved blue line shows the long/short-term movement/fluctuations of p_t^*.

The results show that for the cases of Czech Republic, Latvia, Lithuania, Poland, Slovakia and Slovenia and for Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain and the United Kingdom the public debt had an unstable dynamic over the past decades. The results are intriguing and interesting as well. They reveal that even mature and stable economies such as France, Germany and UKcould experience unstable dynamics of public debt. These findings are explainable for the European peripherals considered as being the weakest economies among EU which are over indebted and unable to grow. For instance, the 2008 banking crisis in Ireland made public debt to boost again after efforts were made over this decade to reduce it from 80% of GDP in 1995 to 25% of GDP in 2007. Cyprus had a high but relatively stable public debt-to-GDP ratio until 2012 when the financial turmoil led to a sharp increase which in 2013 exceeded GDP. For Czech Republic the unstable dynamics of public debt can be argued considering that the small debt ratios over the analyzed period and a GDP growth rate which most of the time exceededthe real interest rate on public debt stimulated the increase of the primary deficit. Under these conditions, the debt ratio grew reaching in 2013 almost 48% of GDP which is 5 times larger than in 1995. Slovenia's situation looks similar to the one described for the Czech Republic. Slovenia had also low public debt-to-GDP ratios but unlike the Czech Republic the real interest rate on public debt

exceeded the real GDP growth rate. This led to a positive debt burden which was not balanced through primary surpluses. Thus, the situation could become worrisome if the government does not make efforts to achieve primary surpluses. Latvia and Lithuania had also small debt ratios, most of the time they achieved low primary deficits and small surpluses, but they had positive flow costs. We may state that *the mirage of low debt* ratiosstimulates government to increase the public debt which can have no negative effects in the short or the mediumterm, but if they do not adjust the primary balance accordingly, fiscal sustainability in the long ran could be seriously affected. The case of Poland is distinct to some extent, because it has one of the highest debt ratio among the Central and Eastern European Countries, which constantly has been larger, it runs most primary deficits and had negative flow costs. In this case, we can talk about *the mirage of negative flow cost* which may drive governments to increase the public debt and to run larger deficits.

The surprise comes from the three mature and stable economies of Europe, France, Germany and UK, which have unstable public debt dynamics. While for the case of Germany the *excess primary balance* indicates small deviations from the steady state for France and UK, *EP* suggestslarge deviations. Both countries experienced the *modified golden rule* of public finance with positive flow costs and small primary surpluses. In 2013, they had debt ratios of almost 95% of GDP. Anecdotally, there are a few voices raising the idea that UKcould join the GIIPSclub. However, investors are still confident in French and British economic conditions and low *Credit Default Swaps* (CDS) spreads for both countries prove it. Thus, we might expect that these countries to delay strong fiscal consolidation and still rely on borrowing money from the financial markets which may foster the instability of public debt.

In order to explain what drives the unstable dynamics of public debt we employed a logit model with fixed effects for a balanced panel represented by 27 European Union countries rangingfrom1998 to2013. The equation below describes the model:

$$P(Y_{it} = 1|X_{it}) = F(\beta_i X_{it} + \alpha_i) \tag{13}$$

where,
$Y_{i,t}$is the dependent variable;
$X_{i,t}$represents one independent variable;
$\alpha_i$is the unknown intercept for each entity, i;
$\beta_1$is the coefficient for that independent variable.

We used as the dependent a dummy variable (*dynamics*) which takes value of 1 each time the *excess of the primary balance* is negative and 0 otherwise. By this, we imply that when $EP<0$ the debt ratio has an unstable dynamics divergent from the steady state. On contrary, when $EP\geq0$ we imply that debt ratio converges towards the steady state. As explanatory variables, we used: the public debt ratio from the previous year (*debt*) arguing that small ratios might stimulate the increase of the public debt and thus unstable dynamics in the long run; the flow cost (*flow*); and the primary deficit (*deficit*). We employed the fixed effects model considering the existing cultural and historical distinctions between the two groups of countries which are time-invariant. By the reason of possible correlations between the variables, we estimated three distinct equations with a single explanatory variable. The results of the estimations and also the odd ratios are reported in Table 1:

Table 1 Logit panel regression with fixed effects

VARIABLES	(1)	(2)	(3)	(4) Odd ratios	(5) Odd ratios
debt	0.00895				
	(0.00797)				
flow		0.431***		1.539***	
		(0.0555)		(0.085)	
deficit			1.434***		4.196***
			(0.172)		(0.720)
Observations	432	432	432	432	432
Number of countries	27	27	27	27	27

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The results indicate that the debt level has no significant influence on public debt dynamics. The probability of unstable dynamics increases with the increase in the flow cost and in the primary deficit. The effect of the primary deficit on debt dynamics is stronger than of the flow cost in the sense that the probability of unstable debt dynamics is higher when running large primary deficits than when having positive and large flow costs.

4.3.Flow cost and the debt burden

In section 2 we learned how the differential between the real interest rate on public debt and the real GDP growth rate influences public debt dynamics. A positive flow cost would impose fiscal adjustments in order to achieve a primary surplus for balancing the increasing debt burden. On contrary, a negative flow cost would allow for more fiscal space due to the decreasing debt burden and governments could implement a more relaxed fiscal policy.

Studying the annual flow cost for the European Union, we found that itexhibits great variability across countries (see Table 1 in the Appendix). We also showed that the flow cost was more favorable to the former communist countries which recorded mostly negative values, while their advanced counterparts recorded positive flow costs. Moreover, the variability of the flow cost captured through the difference between *q3* and *q1* was much higher for the former communist countries than for the advanced economies. The results indicate that Bulgaria and Romania exhibit the greatest variability of the flow cost among the Central and Eastern European countries, whilst Ireland and Greece are accounted for the advanced economies.

The interest rate is an exogenous variable and is less under government's control. The financial markets set the risk premium based on investors' confidence in government policies and on their overall risk aversion.Therefore, the flow cost could turn unexpectedly from a negative one to a positive one, hence generating extra fiscal burden. De Grauwe and Ji (2012) also suggested that following the financial crisis in 2008, investors still might overprice the sovereign bonds risk for countries which are decreasing their public debt. Moreover, given the recent macroeconomic developments and the sharp deflation in the euro zone, the flow cost might increase, hence raising the debt burden.

Thus, we believe that extending our analysis of the flow cost beyond the descriptive statistics and assessing in more detail the distribution of historical data will bring into light relevant aspects which will contribute to a broader image of public debt. In this section, we base our investigation on Aizenman and Pasricha (2010) and intend to show that large values of the flow cost are likely to occur even if the time frame ranges over the last two decades,after MT came into force.

The annual flow cost was highly variable over the sample period for all investigated countries, some of them experiencing quite abrupt changes from one year to another. Therefore, in order to obtain a more coherent image of the evolution of the flow cost and of its variability we also computed the average values for 3 year intervals between 1995 and 2012. We decided to use the 3 years average of the flow cost in order to capture the crisis period and to examine what changes occurred within. The results are reported in Table 3 in the Appendix. The data shows that the flow cost increased during the crisis.

In order to further investigate the variability of the flow cost, especially the possibility to encounter extreme values, we studied its distribution focusing on normality testsand the presence of fat tails (where extreme values occur). Table 4 in the Appendix shows the excess kurtosis of the annual flow cost series and the results of the Shapiro-Wilk normality test.Considering a significance level of 5%, the results show that the distribution of the annual flow cost exhibits significant positive excess kurtosis (i.e. significant fat tails) for 15out of 27 countries (5former communist countries: Estonia, Hungary, Romania, Slovakia and Slovenia;10advanced economies: Austria, Cyprus, Denmark, Finland, France, Ireland, Italy, Malta, Netherlands, and UK). Also, the Shapiro-Wilk test indicates, for the same significance level of 5%, that the flow cost is not normally distributed for 10out of 27 countries (3former communist countries: Estonia, Romania and Slovenia; 7advanced economies: Austria, Cyprus, Denmark, Finland, Ireland, Luxembourg and Portugal). Therefore, it is important to take into account the possibility that EU countries may encounter extreme positive flow costs which, depending on their level of public debt, may lead to important fiscal burdens.

The analysis has been deepened by computing the realized probabilities of recording an extreme positive flow cost for all EU27 countries. These realized probabilities were computed for the thresholds of 5%, 2.5% and 1%, as corresponding to a normal distribution. The results (number of recorded observations and realized probabilities for each threshold) are presented in Table 5 in the Appendix. Confirming the presence of fat tails among the flow cost series, the realized probabilities generally exceed their normal counterparts as follows: the realized probabilities exceed the 5% normal threshold for 25out of 27 countries, the 2.5% normal threshold for 24 out of 27 countries and the 1% normal threshold for 22out of 27 countries.These outcomes are determined by the sharp increase in the flow cost in 2009 observed for all European countries. Thus, it is clear that the flow cost of public debt cannot be modeled using the normal distribution because the probability of extreme events is higher, requesting the use of statistical models that account for fat tails. The possibility of encountering extreme positive levels of flow cost raises concerns about the future debt burden of a country.

For studying the uncertainty of the debt burden, we employ the historical simulation method by taking into account the 3 year average flow costs recorded for the 1995-2012 period for each EU27country. Then, considering the projected public debt-to-GDP ratiosfor each country in the sample, for the year 2018, the debt burden was computed in each scenario. Next, the best scenario (the one with the lowest debt burden) and the worst scenario (the one with the highest debt burden) were selected for each country and, as a measure of uncertainty; the difference between them was computed. The results are shown in Table 6 in Appendix.We can observe that Greece and Ireland has the highest uncertainty among the European countries. For the emerging economies, we found that Poland and Romania confront greater uncertainty. One can notice that in Romania's case the projected debt for 2018 is one of the lowest. However, Romania has higher uncertainty compared to Poland for which the projections indicate a larger debt ratio. The situation can be explained by the reason of high variability of the flow cost. In 1997, Romania recorded the highest flow cost of 84.79%.The National Bank of Romania (1998) reported for 1997 that the interest rate on government domestic borrowings exceeded 100% and for certain bonds issues the interest rate was close to 200%. The way we calculated the uncertainty as a difference between

the worst and the best scenario, it is obvious that this will increase with the public debt to GDP ratio. But, considering the particular case of Romania, we want to examine which affects the most the uncertainty: the variability of the real interest rate on public debt or of the real GDP growth rate. Therefore, we employed an OLS regression described by equation (14):

$$Y_i = \alpha + \beta \sum_{j=1}^{2} X_{i,j} + \varepsilon_i \qquad (14)$$

Where:

Y_i is the dependent variable represented by the uncertainty;

$X_{i,j}$ are the explanatory variables represented by the variability of interest rate and of real GDP growth rate;

α, $\beta$are the coefficients to be estimated;

$\varepsilon_i$are the residuals.

We estimate equation (14) on a cross-section represented by 27 European Union countries. The dependent variable (*uncertainty)* is calculated as the difference between the worst and the best scenario and is reported in Table 6 in the Appendix. The explanatory variables are the variability of the real interest rate on public debt (*varinterest*) and the variability of the real GDP growth rate (*vargrowth*) both calculated as the difference between *q3* and *q1* as reported in Table 1 in the Appendix. The results of OLS are presented in Table 2:

Table 2 OLS cross-section regression

VARIABLES	(1) *uncertainty*
varinterest	0.224
	(0.208)
vargrowth	0.878*
	(0.475)
constant	-0.386
	(1.513)
Observations	27
R-squared	0.311

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The estimations show that, for the European Union countries, the variability of the real GDP growth rate is the factor which drives the uncertainty of the debt burden. Increasing the variability of the economic growth leads to an increase in the uncertainty of 0.8 p.p. On the period under investigation, the real GDP growth rate was less stable than the real interest rate on public debt (see Figure 1 and Table 1 in the Appendix) and this can be a plausible explanation of this finding. The emerging economies in EU exhibited a greater variability of the economic growth compared to the advanced economies. Thus, we believe that the former communist countries are more exposed to the risk of uncertainty of the future debt burden.

5.Concluding remarks

The European sovereign debt crises brought into attention various issues concerning the public debt. It seems that the governments have ignored the sizeable increase in their public debt over the years. Financial markets also stimulated governments to postpone fiscal consolidation. We can recall various reasons: the investors were willing to buy bonds having no fear of governments defaulting their debt; their risk aversion loosened; the risk premium was lower; interest rates also went down over the years. Consequently, governments postponed fiscal adjustments and indulged in playing Ponzi games. The financial crisisof2007-2008 and the deep economic recession afterwards reassessed the entire public debt matter. Nowadays, governments make considerable efforts in fiscal consolidation for keeping the budgetary deficit low and to avoid furtherincreases in the public debt.

Given this context, our paper aimed at providing a comprehensive study of various aspectsconcerning the public debt for a better understanding of this matter. We conducted our analysis on 27 European Union countries using a dataset ranging from 1993 to 2013. The investigation developed manifold. Firstly, we analyzedthe descriptive statistics of key variables which affect public debt dynamics. Thus, we found that in Central and Eastern European countries public debt-to-GDP ratios were lower, the flow cost was negative and they run mostly primary deficits compared to the advanced economies for which we observed larger debt ratios, positive flow costs and primary surpluses.

Secondly, we examined the dynamics of public debt. We conducted the investigation using the *accounting approach* by estimating the*excess of the primary balance* represented by the difference between the*stabilizing* and the actual primary balance. A positive difference suggests stable dynamics while a negative difference indicates unstable dynamics towards the steady state. We found thatfor Czech Republic, Latvia, Lithuania, Poland, Slovakia, and Slovenia and for Cyprus, France, Germany, Greece, Ireland, Italy, Malta, Portugal, Spain and the United Kingdom, the public debt exhibited unstable dynamics over the last 20 years. We also employed a logit model with fixed effects for a panel consisting of 27 European countries to explain what factors influence the instability of thepublic debt dynamics. The results revealed that running primary deficits would increase the probability of having an unstable dynamics compared with an increase in the flow cost which has a smaller influence.

Thirdly, we studied thedistribution of the flow cost using historical data over 1995-2013 period for which we found an increased probability of encountering extreme values. This led us to the conclusion that the probability of large and positive flow cost is greater than expected. Thus, depending on the debt ratio, some of the European countries may be confronted with large debt burdens in the future. Additionally, we found that the uncertainty of the debt burden is driven by the variability of the real GDP growth rates.

The contribution of our study is that it provided an extended investigation of various aspects concerning the public debt and emphasized the existing distinctions between the Central and Eastern European countries and the advanced economies in the European Union. We believe that the former communist countries should learn the *debt story* of the advanced economies and try to avoid falling into the *debt trap*. Having negative flow costs and low debt ratios might be stimulating for many of the Eastern European countries in running deficits and increasing debt. But, in the end,what could make the difference between the two groups of countries are investors' beliefs in governments' ability to handle such situations. Economic instability and governments' inconsistency increase investors' lack of confidenceand they will become more reluctant in lending money or will ask for a higher premium.Eventually, governments have to adjust their fiscal policy but the consolidation effort depends on the size of the budgetary deficit and of the public debt. We showed that running primary deficitsincreases the probability of having unstable dynamics of public debt. This suggests that governments should monitor the budgetary balance more closely irrespective of having or not having a negative flow cost and the primary surplus should be adjusted to compensate the debt burden induced by a positive flow cost.

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APPENDIX: *Tables*

Table 1 Quartiles and the distance between quartiles for EU27

Country	*b*							*y*						
	min	q1	median	q3	max	max-min	q3-q1	min	q1	median	q3	max	max-min	q3-q1
Panel A: Emergingeconomies														
Bulgaria	13.68	17.21	27.48	65.97	108.31	94.63	48.76	-9.03	0.57	3.46	5.86	6.91	15.94	5.28
Czech Republic	11.93	16.81	28.28	31.58	48.33	36.40	14.76	-4.84	0.56	2.71	4.62	6.88	11.72	4.06
Estonia	3.69	4.90	6.01	7.11	10.21	6.52	2.21	-14.74	3.50	6.16	8.09	11.74	26.47	4.59
Hungary	52.66	60.17	65.91	79.43	85.64	32.98	19.25	-6.55	0.83	3.24	4.09	4.79	11.34	3.25
Latvia	9.04	12.38	14.14	28.35	44.45	35.41	15.98	-14.19	2.34	5.35	8.71	11.62	25.81	6.37
Lithuania	11.47	16.67	21.04	26.44	40.67	29.20	9.77	-14.81	3.27	6.11	7.51	11.09	25.90	4.24
Poland	36.79	42.54	47.05	49.93	57.46	20.67	7.39	1.21	3.09	4.26	5.66	7.20	6.00	2.57
Romania	6.58	14.23	21.49	25.31	38.59	32.01	11.08	-7.07	0.12	3.87	6.23	8.46	15.53	6.11
Slovakia	22.08	32.42	40.99	45.61	54.64	32.56	13.19	-5.29	2.15	4.83	5.95	10.68	15.97	3.80
Slovenia	18.60	23.11	26.54	31.39	61.02	42.42	8.29	-7.80	2.03	3.52	4.25	6.94	14.74	2.22
Panel B: Advanced economies														
Austria	60.22	64.31	66.21	68.69	73.80	13.58	4.39	-3.80	1.45	2.21	3.21	3.62	7.42	1.76
Belgium	84.01	94.78	99.63	110.67	130.18	46.17	15.89	-2.62	0.94	1.89	2.82	3.74	6.36	1.88
Cyprus	48.89	58.66	61.18	69.55	109.54	60.65	10.89	-5.36	1.51	3.58	4.60	9.92	15.28	3.09
Denmark	27.13	41.71	46.39	55.24	72.58	45.45	13.53	-5.09	0.43	1.63	2.92	3.80	8.88	2.50
Finland	33.94	42.08	44.51	51.02	56.95	23.01	8.93	-8.27	1.84	2.99	4.33	6.25	14.52	2.49
France	55.41	58.94	63.95	73.70	94.03	38.62	14.76	-2.94	0.97	1.97	2.37	3.88	6.82	1.40
Germany	55.60	60.34	65.21	71.52	82.37	26.77	11.19	-5.64	0.54	1.70	2.49	4.09	9.73	1.94
Greece	94.86	99.05	104.39	121.29	175.18	80.32	22.24	-8.86	-1.88	3.07	4.01	6.64	15.50	5.89
Ireland	24.62	31.38	46.97	76.16	123.33	98.71	44.78	-6.37	1.47	5.27	8.82	10.78	17.15	7.34
Italy	103.28	105.90	113.01	119.77	131.41	28.13	13.87	-5.48	0.20	1.47	1.74	3.71	9.19	1.54
Luxembourg	6.07	6.34	7.10	14.89	23.39	17.32	8.55	-5.33	1.47	3.28	5.54	8.44	13.78	4.07
Malta	34.21	54.52	60.91	67.68	73.90	39.68	13.16	-2.46	2.10	3.35	3.99	6.41	8.88	1.88
Netherlands	45.29	51.91	60.76	66.95	76.08	30.78	15.03	-3.30	0.67	2.08	3.92	4.53	7.83	3.25
Portugal	50.67	56.15	61.91	77.70	123.62	72.95	21.55	-3.32	-0.37	1.81	2.99	4.79	8.11	3.36
Spain	36.30	47.52	59.38	65.16	91.34	55.04	17.64	-3.57	0.56	3.17	3.88	5.29	8.86	3.32
Sweden	38.19	40.44	50.40	59.52	73.29	35.10	19.08	-5.18	1.54	2.82	4.27	5.99	11.17	2.73
United Kingdom	37.71	41.65	46.47	60.06	95.46	57.76	18.41	-4.31	1.82	2.66	3.50	4.35	8.66	1.68

Table 1 (continued)

Country	*r*							*p*						
	min	q1	median	q3	max	max-min	q3-q1	min	q1	median	q3	max	max-min	q3-q1
Panel A: Emerging economies														
Bulgaria	-13.46	-2.05	-0.46	2.44	4.29	17.76	4.49	-3.57	0.57	2.65	4.55	10.48	14.05	3.98
Czech Republic	-2.35	1.20	1.48	2.50	4.76	7.11	1.30	-11.78	-4.12	-2.63	-1.81	0.36	12.13	2.31
Estonia	-16.73	-2.46	-0.65	1.10	4.09	20.81	3.56	-3.17	-0.12	0.33	1.84	2.63	5.81	1.96
Hungary	-10.47	-0.07	0.96	2.91	3.83	14.30	2.98	-5.50	-1.51	0.12	1.92	8.39	13.90	3.43
Latvia	-8.16	-1.81	1.83	3.92	6.01	14.17	5.73	-8.26	-1.95	-0.64	0.13	2.38	10.63	2.07
Lithuania	-15.57	0.89	2.69	5.32	7.95	23.53	4.43	-11.01	-2.51	-1.41	-0.57	0.30	11.32	1.93
Poland	-8.23	1.01	2.64	3.89	6.55	14.78	2.87	-5.17	-2.22	-1.26	-0.18	1.33	6.49	2.05
Romania	-61.53	-9.39	-0.99	0.90	5.51	67.04	10.29	-7.47	-1.99	-0.72	0.09	0.74	8.22	2.08
Slovakia	-2.62	0.02	1.43	2.43	6.99	9.61	2.40	-8.21	-4.35	-2.51	-1.06	-0.18	8.03	3.28
Slovenia	-0.48	1.86	2.86	3.23	5.24	5.72	1.37	-6.18	-2.41	-0.72	-0.09	1.22	7.40	2.33
Panel B: Advanced economies														
Austria	0.50	2.18	3.05	3.87	4.92	4.42	1.69	-1.84	-0.01	1.18	1.71	3.32	5.16	1.71
Belgium	0.04	2.00	3.57	4.28	5.49	5.45	2.29	-1.93	0.93	4.34	5.52	6.84	8.77	4.58
Cyprus	0.56	1.74	2.58	3.42	4.85	4.29	1.68	-3.93	-2.79	-1.07	1.12	6.55	10.48	3.90
Denmark	1.15	2.62	3.67	4.30	6.08	4.93	1.68	-2.35	1.36	4.42	5.04	7.10	9.45	3.69
Finland	-1.02	1.43	3.25	4.58	7.04	8.06	3.15	-2.19	-0.24	4.37	5.72	9.82	12.01	5.95
France	1.05	2.12	2.92	4.21	5.44	4.39	2.09	-5.14	-1.74	-0.41	0.18	1.36	6.50	1.92
Germany	1.12	2.24	3.29	3.99	5.85	4.73	1.74	-5.98	-0.69	0.64	2.02	4.34	10.32	2.70
Greece	-0.42	1.36	2.56	3.92	5.68	6.10	2.55	-10.45	-2.48	-0.74	2.81	4.37	14.82	5.29
Ireland	-0.53	0.54	1.82	4.06	8.62	9.15	3.52	-27.67	-3.15	2.45	4.10	6.74	34.41	7.25
Italy	1.22	2.42	3.00	3.87	6.06	4.83	1.45	-0.84	1.20	2.47	4.29	6.51	7.35	3.08
Luxembourg	-0.82	0.60	1.81	3.48	8.09	8.91	2.89	-0.93	0.19	1.61	3.75	6.44	7.37	3.56
Malta	1.25	2.59	3.20	4.47	5.17	3.92	1.88	-6.54	-3.21	-1.47	-0.33	0.95	7.49	2.87
Netherlands	0.19	2.24	3.11	4.30	5.83	5.64	2.06	-3.58	-1.94	2.08	3.16	5.62	9.21	5.10
Portugal	0.62	1.76	2.04	3.60	6.33	5.72	1.84	-7.32	-1.84	-0.79	-0.27	0.23	7.55	1.57
Spain	0.48	1.49	1.81	4.05	5.40	4.92	2.56	-9.41	-3.05	1.19	2.38	4.01	13.41	5.43
Sweden	-0.27	1.93	2.90	5.05	7.01	7.28	3.13	-2.03	1.04	2.22	4.13	7.05	9.08	3.09
United Kingdom	-0.18	1.65	3.92	5.04	5.81	5.99	3.39	-9.49	-3.05	-1.33	0.65	6.31	15.80	3.71

Table 1 (continued)

Country	ε							π^*- π						
	min	q1	median	q3	max	max-min	q3-q1	min	q1	median	q3	max	max-min	q3-q1
Panel A: Emerging economies														
Bulgaria	-16.98	0.84	3.55	6.27	33.44	50.42	5.43	-1051.05	-6.04	-3.28	-0.35	0.62	1051.66	5.68
Czech Republic	-3.76	-0.83	3.01	6.02	15.00	18.76	6.85	-6.05	-0.69	-0.19	0.59	2.04	8.09	1.27
Estonia	-0.93	1.38	2.11	4.10	23.00	23.93	2.72	-6.74	-2.60	-1.29	-0.72	1.08	7.83	1.88
Hungary	-5.04	-0.86	2.10	4.45	10.22	15.26	5.32	-10.97	-6.00	-3.02	-2.44	-0.19	10.78	3.56
Latvia	-6.32	0.01	2.18	7.88	16.34	22.65	7.88	-11.73	-3.95	-0.80	0.65	3.15	14.88	4.60
Lithuania	-1.89	0.17	2.41	6.57	23.94	25.82	6.40	-7.27	-1.43	-0.37	1.83	3.27	10.54	3.26
Poland	-14.66	-1.86	2.81	8.35	12.64	27.31	10.20	-7.57	-2.52	-1.06	0.18	1.34	8.91	2.70
Romania	-12.49	-4.80	1.21	7.51	28.46	40.95	12.32	-147.44	-31.27	-6.70	-4.00	-0.66	146.78	27.27
Slovakia	-2.62	1.07	3.09	7.84	11.74	14.36	6.77	-8.58	-4.13	-0.94	-0.43	1.22	9.80	3.70
Slovenia	-4.07	-0.62	0.18	1.48	9.58	13.66	2.11	-5.42	-3.26	-1.24	-0.16	1.29	6.72	3.11
Panel B: Advanced economies														
Austria	-3.59	-0.80	-0.52	0.49	2.02	5.61	1.29	-0.49	0.22	0.48	0.85	6.03	6.52	0.63
Belgium	-4.21	-0.56	-0.16	0.50	2.76	6.97	1.07	-0.84	-0.09	0.54	0.91	5.70	6.54	1.01
Cyprus	-2.21	-0.39	0.07	0.79	3.73	5.95	1.18	-2.00	-0.28	-0.01	1.21	3.72	5.72	1.49
Denmark	-2.38	-1.21	-0.49	1.04	3.79	6.17	2.24	-0.32	0.24	0.47	0.71	5.13	5.45	0.46
Finland	-4.72	-1.55	-0.27	1.21	6.70	11.42	2.76	-0.40	0.03	0.86	1.43	6.10	6.50	1.40
France	-3.67	-0.91	-0.50	0.04	2.12	5.79	0.96	0.03	0.61	0.85	1.57	6.13	6.10	0.95
Germany	-4.91	-1.37	-0.71	0.15	3.32	8.23	1.52	0.01	0.67	0.99	1.22	5.42	5.42	0.55
Greece	2.31	4.53	5.32	8.37	13.07	10.76	3.84	-2.63	-0.89	-0.24	0.31	2.43	5.06	1.20
Ireland	-4.66	-0.49	0.41	2.16	5.08	9.74	2.65	-2.50	-1.63	0.09	1.32	5.88	8.38	2.95
Italy	-7.92	-0.32	0.16	0.73	10.99	18.91	1.05	-0.56	0.09	0.31	0.52	5.33	5.89	0.43
Luxembourg	-4.09	-0.04	0.63	1.25	2.92	7.01	1.29	-0.36	-0.19	0.14	0.50	5.93	6.29	0.69
Malta	-2.03	-0.40	0.25	2.64	5.38	7.41	3.04	-1.11	-0.47	0.34	0.83	4.22	5.32	1.30
Netherlands	-3.66	-0.83	-0.41	1.87	3.37	7.03	2.70	-1.30	0.04	0.77	1.08	5.13	6.43	1.04
Portugal	-1.77	-0.42	0.20	0.63	2.73	4.50	1.06	-1.17	-0.56	0.01	1.07	4.99	6.16	1.63
Spain	-3.85	0.17	0.75	1.29	2.69	6.54	1.12	-1.21	-0.74	-0.10	0.29	5.35	6.56	1.03
Sweden	-8.41	-2.70	-0.52	1.57	10.51	18.92	4.27	0.13	0.40	1.48	1.89	6.82	6.69	1.49
United Kingdom	-13.84	-3.23	0.40	2.74	19.23	33.07	5.97	-1.37	-0.18	0.24	1.64	5.51	6.88	1.82

Table 1 (continued)

Country	γ							φ						
	min	q1	median	q3	max	max-min	q3-q1	min	q1	median	q3	max	max-min	q3-q1
Panel A: Emerging economies														
Bulgaria	-16.93	-8.40	-5.34	1.99	8.06	24.99	10.39	-1017.60	-0.53	-0.10	0.36	2.33	1019.93	0.89
Czech Republic	-5.34	-3.58	-0.48	1.47	8.22	13.56	5.05	-3.40	-0.72	1.62	4.59	12.36	15.76	5.30
Estonia	-22.62	-10.05	-6.05	-3.74	18.82	41.44	6.31	-1.49	-0.46	0.45	1.02	3.78	5.27	1.49
Hungary	-10.50	-3.23	-0.75	-0.35	8.57	19.08	2.88	-10.53	-4.02	-2.28	0.73	6.24	16.77	4.75
Latvia	-15.18	-9.26	-4.39	-0.64	16.89	32.08	8.62	-7.11	-1.67	-0.11	2.04	10.21	17.32	3.71
Lithuania	-20.81	-6.33	-3.34	0.11	17.07	37.89	6.44	-1.12	-0.35	0.80	4.59	18.23	19.35	4.94
Poland	-14.47	-4.19	-1.66	0.60	4.63	19.10	4.80	-17.18	-3.54	-1.76	5.73	12.52	29.70	9.27
Romania	-56.72	-14.66	-6.74	-1.43	12.57	69.29	13.23	-127.60	-25.99	-9.28	0.07	12.41	140.01	26.06
Slovakia	-8.41	-5.28	-2.52	-0.30	8.56	16.96	4.98	-10.06	0.08	2.67	5.26	8.49	18.54	5.18
Slovenia	-5.22	-1.92	-0.63	1.23	12.75	17.96	3.15	-6.08	-2.19	-0.30	0.20	2.43	8.51	2.39
Panel B: Advanced economies														
Austria	-2.57	-0.27	1.22	1.50	7.54	10.10	1.77	-0.84	-0.14	0.34	1.60	2.88	3.72	1.74
Belgium	-1.60	-0.12	0.95	2.74	6.67	8.27	2.87	-0.83	0.06	0.62	1.68	3.05	3.88	1.61
Cyprus	-3.49	-1.51	-0.98	0.37	10.10	13.60	1.89	-1.43	-0.02	0.63	1.74	2.70	4.13	1.75
Denmark	-1.12	0.89	2.50	3.04	8.78	9.90	2.15	-1.84	-0.13	0.14	1.95	3.47	5.31	2.08
Finland	-3.65	-1.16	0.48	1.54	11.40	15.05	2.70	-1.06	-0.44	0.98	1.62	4.99	6.05	2.06
France	-0.93	0.25	1.55	2.12	6.29	7.22	1.87	-0.54	0.06	0.45	2.14	3.29	3.83	2.08
Germany	-2.46	0.69	1.71	3.28	9.18	11.64	2.59	-1.29	0.00	0.44	1.66	3.37	4.66	1.66
Greece	-4.85	-0.74	0.74	3.81	10.05	14.90	4.55	1.66	3.93	4.38	6.56	12.14	10.48	2.63
Ireland	-10.05	-5.43	-4.64	0.29	14.99	25.05	5.71	-2.33	-1.22	0.10	1.33	8.29	10.62	2.55
Italy	-0.45	1.19	2.21	3.62	8.98	9.43	2.44	-0.81	-0.04	0.61	1.74	6.23	7.04	1.78
Luxembourg	-5.83	-4.21	-1.52	0.71	7.31	13.14	4.92	-0.36	0.44	0.89	1.85	3.31	3.67	1.41
Malta	-2.09	-0.33	0.63	1.17	5.42	7.52	1.50	-1.19	-0.40	0.05	3.20	9.60	10.79	3.60
Netherlands	-0.93	0.18	0.89	2.07	5.71	6.64	1.89	-1.04	-0.06	0.71	1.66	2.78	3.82	1.72
Portugal	-1.28	-0.22	1.04	2.46	7.69	8.97	2.68	-0.47	-0.05	0.46	1.56	3.22	3.69	1.60
Spain	-3.57	-1.90	-0.63	1.79	8.11	11.68	3.69	-0.67	0.07	0.35	1.50	2.58	3.26	1.43
Sweden	-5.09	-0.93	0.88	1.42	8.08	13.17	2.35	-7.67	-0.59	1.52	3.02	11.44	19.10	3.61
United Kingdom	-1.82	-0.04	1.46	1.94	5.89	7.71	1.98	-13.81	-1.08	-0.41	3.83	24.74	38.56	4.91

Table 2 Stable vs.unstable public debt dynamics in EU, 1996-2013

Country	*EP*	Dynamics
Panel A: Emerging economies		
Bulgaria	67.38	Y
Czech	-46.99	N
Estonia	14.91	Y
Hungary	21.27	Y
Latvia	-15.63	N
Lithuania	-34.40	N
Poland	-8.72	N
Romania	2.75	Y
Slovakia	-38.97	N
Slovenia	-25.14	N
Panel B: Advanced economies		
Austria	4.17	Y
Belgium	37.23	Y
Cyprus	-15.73	N
Denmark	40.94	Y
Finland	61.02	Y
France	-30.09	N
Germany	-3.61	N
Greece	-57.68	N
Ireland	-7.82	N
Italy	-6.63	N
Luxembourg	38.59	Y
Malta	-42.10	N
Netherlands	10.23	Y
Portugal	-52.71	N
Spain	-16.37	N
Sweden	42.51	Y
UK	-27.88	N

Note: Y-stable dynamics; N-unstable dynamics based on the results for EP

Table 3 Average flow cost for 3 years intervals between 1995 and 2012

Country	1995-1997	1998-2000	2001-2003	2004-2006	2007-2009	2010-2012	2013
Panel A: Emerging economies							
Bulgaria	NA	-6.39	-4.76	-7.38	-4.47	0.88	3.23
Czech Republic	NA	-0.10	0.05	-4.40	-0.31	0.41	2.73
Estonia	NA	-4.77	-6.08	-8.12	3.10	-6.71	-2.71
Hungary	NA	-2.91	-1.55	-1.58	2.13	0.07	2.23
Latvia	NA	-0.09	-3.53	-11.88	-1.09	-0.56	-0.36
Lithuania	NA	2.63	-1.77	-5.28	-1.38	-1.19	0.49
Poland	NA	-5.03	3.27	-0.82	-2.44	-1.57	2.38
Romania	NA	-13.54	-15.22	-8.37	-0.53	0.58	-2.52
Slovakia	NA	-2.03	-3.25	-6.59	-1.77	-1.75	0.94
Slovenia	NA	-0.87	-1.42	-1.39	1.25	2.91	3.51
Panel B: Advanced economies							
Austria	1.69	0.77	1.67	-0.14	2.05	-0.65	1.42
Belgium	2.34	1.49	2.60	-0.16	1.90	-0.64	1.87
Cyprus	NA	-1.95	-0.37	-1.52	0.58	1.67	10.10
Denmark	2.77	1.47	3.29	0.14	4.69	0.81	2.91
Finland	2.03	-0.40	1.48	-0.93	2.37	-1.48	1.70
France	3.05	0.78	2.03	0.14	2.83	-0.20	1.64
Germany	3.49	2.19	3.32	0.94	2.86	-1.12	1.39
Greece	1.04	1.42	-2.11	-2.13	2.31	7.62	6.55
Ireland	-5.29	-7.28	-4.46	-4.04	4.44	2.19	3.72
Italy	3.72	1.89	2.06	1.03	4.43	1.72	4.93
Luxembourg	2.64	-3.86	0.16	-4.11	1.20	-2.81	-1.45
Malta	NA	0.14	1.82	0.53	1.22	-0.12	0.71
Netherlands	1.92	0.19	1.78	0.68	1.75	0.82	0.91
Portugal	2.11	-0.67	1.09	0.40	2.96	2.35	4.61
Spain	2.00	-1.13	-1.58	-2.74	1.75	2.38	3.79
Sweden	3.59	1.21	0.72	-1.35	2.61	-2.24	0.52
UK	1.50	2.06	1.25	0.56	2.81	-0.79	-0.96

Table 4 Excess kurtosis and Shapiro-Wilk normality test for the annual flow cost

Country	Number of observations	Excess kurtosis	p-value	Shapiro-Wilk test	Critical value (5%)
Panel A: Emerging economies					
Bulgaria	16	-0.56	60.30%	0.969	0.887
Czech Republic	18	0.68	50.92%	0.938	0.897
Estonia	18	3.82	0.02%	0.892	0.897
Hungary	18	3.00	0.38%	0.907	0.897
Latvia	18	1.72	9.70%	0.937	0.897
Lithuania	18	1.65	11.18%	0.965	0.897
Poland	18	1.49	14.98%	0.943	0.897
Romania	18	6.26	0.00%	0.825	0.897
Slovakia	18	2.11	4.14%	0.921	0.897
Slovenia	18	5.48	0.00%	0.824	0.897
Panel B: Advanced economies					
Austria	19	6.54	0.00%	0.817	0.901
Belgium	19	1.23	22.62%	0.927	0.901
Cyprus	18	3.19	0.20%	0.777	0.897
Denmark	19	4.57	0.00%	0.851	0.901
Finland	19	6.41	0.00%	0.822	0.901
France	19	2.30	2.32%	0.921	0.901
Germany	19	1.81	7.34%	0.946	0.901
Greece	19	-0.35	72.64%	0.947	0.901
Ireland	19	2.84	0.52%	0.841	0.901
Italy	19	3.16	0.18%	0.903	0.901
Luxembourg	19	0.53	59.62%	0.897	0.901
Malta	18	2.14	3.84%	0.939	0.897
Netherlands	19	2.37	1.88%	0.912	0.901
Portugal	19	1.28	20.40%	0.890	0.901
Spain	19	0.99	32.70%	0.926	0.901
Sweden	19	1.16	25.02%	0.961	0.901
UK	19	2.79	0.60%	0.908	0.901

Table 5 Realized probabilities of extreme positive flow costs

Country	Total number of observations	Number of observations exceeding the 5% normal threshold (realized probabilities in brackets)	Number of observations exceeding the 2.5% normal threshold (realized probability in brackets)	Number of observations exceeding the 1% normal threshold (realized probability in brackets)
Panel A: Emerging economies				
Bulgaria	16	2 (12.5%)	0 (0%)	0 (0%)
Czech Republic	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Estonia	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Hungary	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Latvia	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Lithuania	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Poland	18	0 (0%)	0 (0%)	0 (0%)
Romania	18	0 (0%)	0 (0%)	0 (0%)
Slovakia	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Slovenia	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Panel B: Advanced economies				
Austria	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Belgium	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Cyprus	18	2 (11.11%)	1 (5.56%)	1 (5.56%)
Denmark	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Finland	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
France	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Germany	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Greece	19	1 (5.26%)	1 (5.26%)	0 (0%)
Ireland	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Italy	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Luxembourg	19	2 (10.53%)	2 (10.53%)	0 (0%)
Malta	18	1 (5.56%)	1 (5.56%)	1 (5.56%)
Netherlands	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Portugal	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Spain	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
Sweden	19	1 (5.26%)	1 (5.26%)	1 (5.26%)
UK	19	1 (5.26%)	1 (5.26%)	1 (5.26%)

Note: the realized probabilities are calculated as number of observations exceeding the threshold ratio to total number of observations

Table 6 Historical best and worst scenarios for the debt burden in 2018

Country	IMF debt projections for 2018	Worst scenario (max. burden)	Best scenario (min. burden)	Uncertainty (Worst-Best)
Panel A: Emerging economies				
Bulgaria	17.17	0.15	-1.27	1.42
Czech Republic	50.43	0.21	-2.22	2.43
Estonia	8.13	0.25	-0.66	0.91
Hungary	78.81	1.68	-2.29	3.97
Latvia	26.35	-0.02	-3.13	3.11
Lithuania	41.56	1.09	-2.19	3.29
Poland	49.88	1.63	-2.51	4.14
Romania	36.23	0.21	-5.52	5.73
Slovakia	59.05	-1.03	-3.89	2.86
Slovenia	77.75	2.26	-1.10	3.37
Panel B: Advanced economies				
Austria	71.79	1.47	-0.47	1.94
Belgium	92.12	2.40	-0.59	2.99
Cyprus	111.65	1.86	-2.18	4.04
Denmark	48.02	2.25	0.07	2.18
Finland	58.92	1.39	-0.87	2.27
France	88.80	2.71	-0.18	2.89
Germany	67.70	2.37	-0.76	3.13
Greece	142.61	10.87	-3.04	13.91
Ireland	109.85	4.88	-8.00	12.88
Italy	123.05	5.45	1.27	4.18
Luxembourg	33.44	0.88	-1.37	2.26
Malta	73.91	1.35	-0.09	1.44
Netherlands	83.21	1.60	0.15	1.44
Portugal	116.04	3.44	-0.78	4.22
Spain	105.07	2.50	-2.88	5.39
Sweden	34.20	1.23	-0.76	1.99
UK	96.71	2.71	-0.77	3.48

Note: the data for public debt –to- GDP ratio provided by International Monetary Fund (2013)