AVOIDING DEBT TRAPS: FINANCIAL BACKSTOPS AND STRUCTURAL REFORMS

(PROVISONAL DRAFT)

by

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ABSTRACT

In this paper we develop a simple analytical framework to analyze "good" and "bad equilibria" in public-debt and growth dynamics. The "bad equilibrium" is characterised by the simultaneous occurrence, and adverse feedbacks between, high and growing fiscal deficits and debt, high risk premia on sovereign debt, slumping economic activity and plummeting confidence, whereas a "good equilibrium" is characterized by stable growth and debt and low risk premia. We use this framework to identify – both theoretically and empirically – the good and bad equilibrium levels of debt and policies that can help a country caught in a bad equilibrium to recover. The analysis shows that despite some output loss in the short run fiscal consolidation can help countries escape from the bad equilibrium trap. More broadly, we find that a combination of financial backstops, structural reform and fiscal consolidation can help countries to escape from this trap.

JEL classification codes: E62, C33, C62.

Key words: fiscal policy; sovereign debt, multiple equilibria.

Paper presented at the 9th EUROFRAME Conference on Economic Policy Issues in the European Union: "The euro area in crisis: challenges for monetary and fiscal policies, and prospects for monetary union", 8th June 2012, Kiel, Germany. The views expressed in this paper are those of the authors and do not necessarily reflect those of the OECD or the governments of its Member countries. Corresponding author: Paul van den Noord, OECD, 2 rue André Pascal - 75775 Paris Cedex 16, Tel: +33 1 45 24 98 60, email: paul.vandennoord@oecd.org,

1. Introduction

One of the consequences of the current macroeconomic environment is that an economy may find itself trapped in a "bad equilibrium". One often hears the case made of periphery countries in the euro area being in such a "bad equilibrium", which is characterised by the simultaneous occurrence, and adverse feedbacks between, high and growing fiscal deficits and debt, high risk premia on sovereign debt, slumping economic activity and plummeting confidence. Remedies to break the downward spiral and escaping debt traps are generally deemed to include financial firewalls to prevent contagion and structural reforms to boost growth or expectations thereof. The role of fiscal policy is less clear, as consolidation may help to put debt on a sustainable path, but negative demand effects may generate offsets or could exacerbate the downturn, add to the risk premiums, and thus deepen the "bad equilibrium".

While these general mechanisms are well understood, how they interact in a consistent dynamic setting is less clear. In this paper we provide a simple analytical framework to fill this gap. We develop a simple version of a model with two equilibria -- combining a negative relationship between debt and growth inspired by the seminal work of Reinhart and Rogoff (2010) and the government's inter-temporal budget constraint . We later extend this model to make it more realistic by adding the effects of fiscal policy and interest rates on growth and introducing an interest rate equation, and subsequently estimate it. We then use the model to identify empiricaly the good and bad equilibrium levels of debt and growth and policies that can help a country caught in a bad equilibrium to recover. This model embeds all three relevant sets of policy variables: structural reform, fiscal consolidation and the use of financial backstops to reduce the bond yield.

We start the paper with a brief recount of stylised developments since the onset of the crisis. We then elaborate the theoretical model, report the estimation results of a panel regression analysis and finally examine the comparative static and dynamic responses to fiscal, structural and financial policies. The final section concludes.

2. Some stylised developments

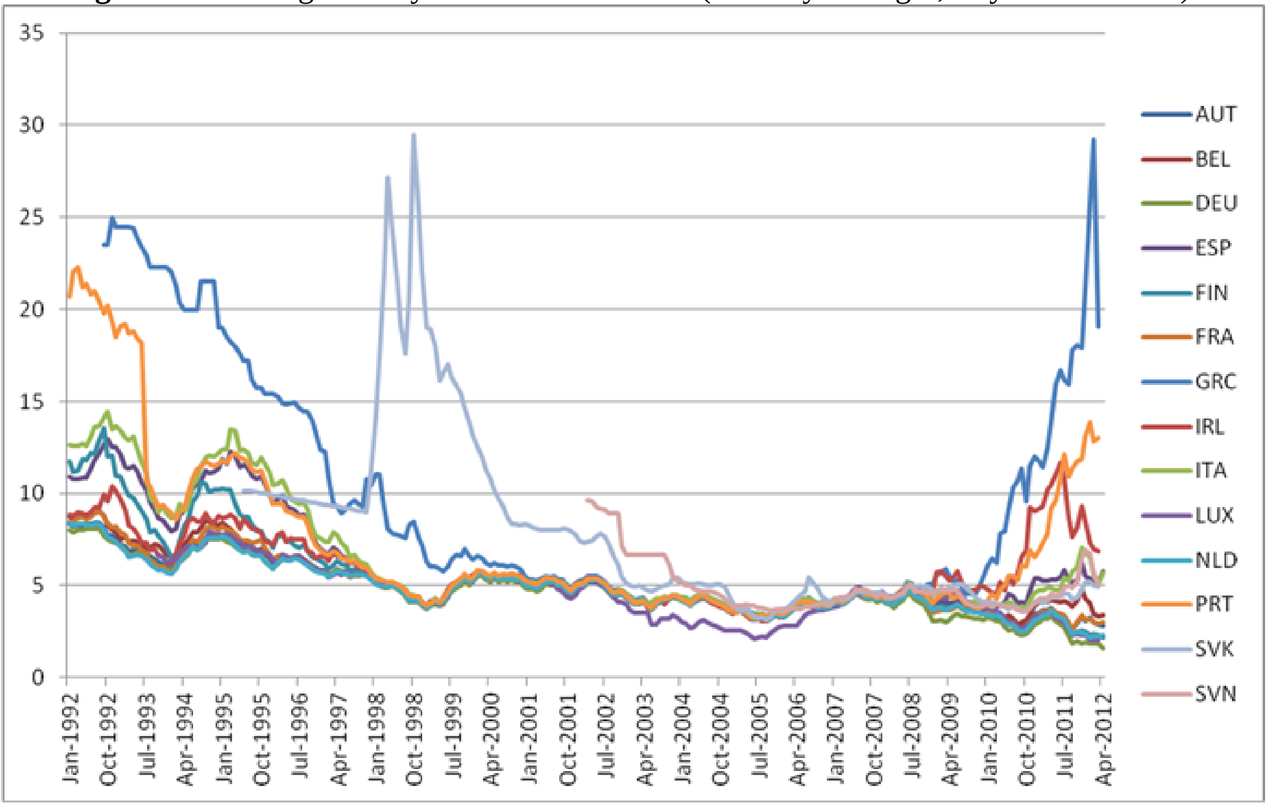
Over the past few years, even before the breakout of the global financial crisis, new stylized facts have emerged in the macroeconomic environment. Public debt has grown significantly in almost all advanced economies, also as a consequence of the crisis, partly fueled by the drop in public revenues caused by the recession and partly because of the large public efforts, especially in some countries, to deal with banking crises. This has generated a negative feedback on growth with the possibility of a vicious circle of high debt, low growth and unsustainable public debt dynamics. The negative correlation between debt and growth has been explained in different ways (Cecchetti at al 2012, Elmeskov and Sutherland 2012, Reinhart and Rogoff 2010 and others), but there is evidence that beyond a threshold debt ratios negatively affect growth. Fragility has spilled over to banks which hold substantial amounts of sovereign debt in their balance sheets, especially in the euro area. This has, in turn, weighed negatively on confidence as the risk of a possible twin crisis affecting sovereign debt and credit markets has become more significant. Confidence can affect growth significantly. Simulations by the OECD (2011) point at a chain of causation which goes from confidence (in both business and household) to financial markets to the real economy. Such a relationship can work both ways, affecting growth positively or negatively and leading to significant differences in performance.

The increased role of confidence in driving macroeconomic performance suggests that we are operating in a world of multiple equilibria, where expectations play a key role. The experience, however, also points also to an overreaction of markets, again especially in the euro area. Take interest rates on sovereign bonds for example (Figure 1). After the crisis of the EMS in 1992, and in the run up to monetary union, these had converged significantly and spreads practically disappeared for a number of years. After the outbreak of the crisis markets overreacted in the opposite direction amplifying risk assessment and contributing to the emergence of vicious circles.

More generally, in OECD economies, for quite some time, markets have underpriced risk and favoured excessive risk taking including in private debt accumulation. During the so called great moderation in the US they have fuelled credit and housing booms and strengthened the perception that private debt was, after all, sustainable. An indication of this is the persistence of a negative interest rate-growth rate differential for OECD economies (Turner and Spinelli, 2011). In the euro area, this general pattern has taken the form of the expansion of current account (saving-investment) imbalances (OECD euro area EDRC) which was fed largely through the banking sector, unsustainable investment, and housing booms in deficit countries and the outflow of capital from surplus countries.

Dealing with such a situation is posing very severe policy challenges. The loss of fiscal policy space inevitably requires that fiscal action is directed towards consolidation. Benefits of fiscal consolidation are long term, as reducing debt levels breed stronger growth, but also short term to the extent that credible fiscal consolidation programs may boost market confidence which translates into lower risk premia. However, in the short term the negative impact on demand may adversely affect market confidence to the extent that it depresses growth and hence debt sustainability. In practice, which of the two effects of fiscal consolidation prevails is an empirical issue largely dependent on the size of the fiscal multiplier.

Figure 1: Sovereign bond yields in the euro area (monthly averages,10-year maturities)

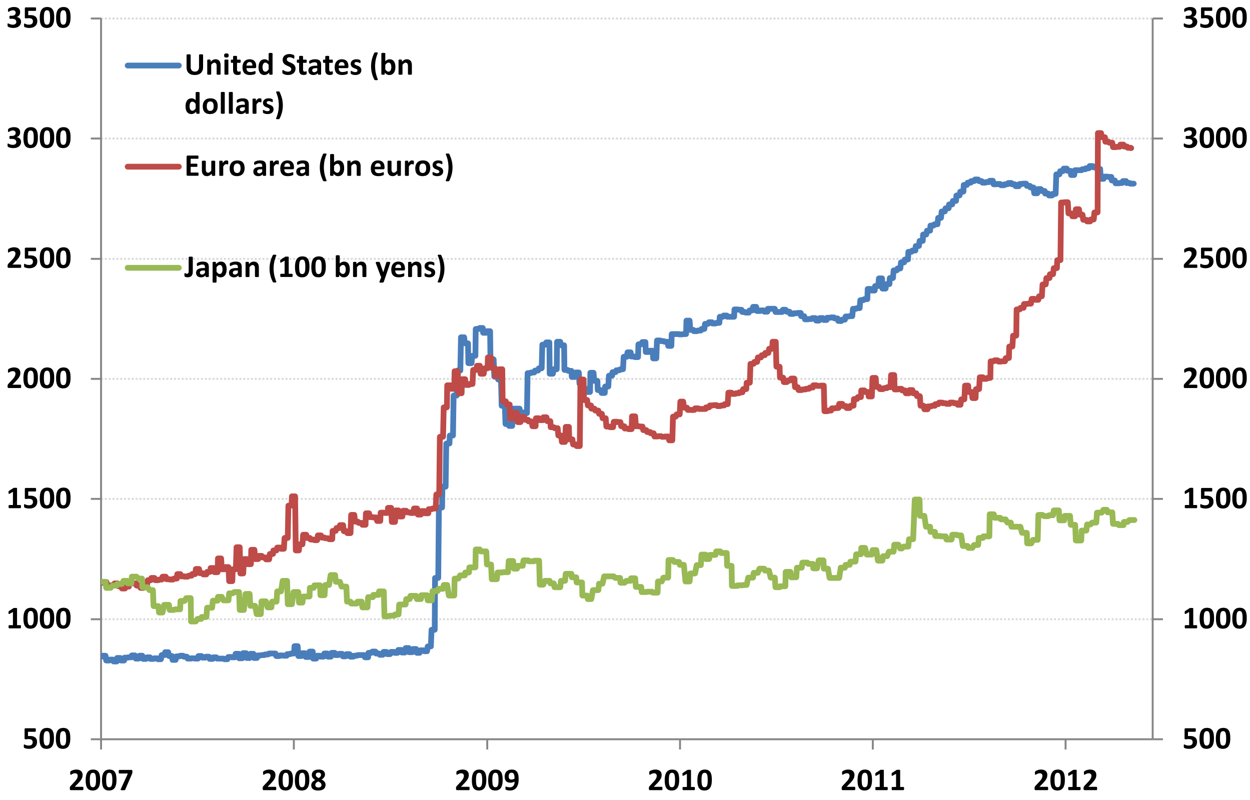


Source: OECD Analytical Database.

Monetary policy in many advanced economies has reached the zero bound and, since the crisis, monetary authorities have introduced “unconventional“ measures to deal with the recession. The balance sheets of major central banks have expanded accordingly (Figure 2). However, in a situation of financial fragility where multiple equilibria may materialize monetary authorities can fulfill an additional function with respect to supporting economic activity (in a framework of price stability and anchored inflation expectations), the “lender of last resort” function which can involve both sovereign debt and credit markets. Such a provision of financial backstop is particularly relevant in situations in which, like the euro area crisis, contagion effects can be very significant and affecting several channels at the same time.

The available policy toolkit also includes structural reforms. Structural reforms, which consist of a large number of different measures, can have a significant impact on growth (OECD, 2012a), but the benefits of growth require time to materialize in full.

Figure 2: Central bank liabilities (in local currency)



Source: Federal Reserve; Bank of Japan; European Central Bank.

Since the beginning of the crisis many countries have enacted structural reforms, often in tandem with fiscal consolidation measures (OECD, 2012b). This bodes well for the future, but time may be too short for the benefits of structural reforms to materialize and for markets to appreciate such improvements and translate them into lower risk premia. If markets are patient, debt sustainability would be easier and good equilibria could be reached where lower risk premia and higher growth reinforce each other. But if markets are impatient, good equilibria may never be reached. Rather, bad equilibria, characterized by high risk premia and low growth may prevail, leading countries towards unsustainable debt dynamics. This calls for a coordinated action where available policy tools, fiscal, monetary, and structural policies must operate in coordination to allow economies to move towards good equilibria. What such a coordinated solution might look like is the subject of the rest of this paper.

3. Theoretical model

In this section we provide a consistent yet simple analytical framework to analyze the interactions described in the previous section. It is inspired by a model developed by Duesenberry (1958) to analyze the

Great Depression which had very similar characteristics. We start of with a very simple version (the "core model"), which we later extend and make more realistic.

3.1 Core version of the model

The "core model" consists of two very basic differential equations explaining growth of output and debt, respectively. We dub the first equation the "Reinhard-Rogoff rule" (RRR), which postulates output growth to be a negative function of the (public) debt to output ratio (*Y* = output, *D* = public debt and a dot denotes the first derivative):

$$\frac{\dot{Y}}{Y} = a - b\frac{D}{Y} \qquad (1)$$

In this equation the parameter *a* is the exogenous component of output growth, which is assumed to take a positive value and to increase if structural reform is implemented. Equation (1) is depicted in the upper-left panel of Figure 3 as the straight downward sloping line marked RRR.

The other differential equation is the "Fixed Primary Deficit Rule" (FPR). The FPR sets a target *p* for the primary deficit as a share of GDP. Incorporating this in the government budget constraint (*r* = the interest rate on government debt *D*) yields:

$$\dot{D} = rD + pY \qquad (2)$$

A simplifying assumption is that a change in the interest rate instantaneously applies to debt of all maturities. An alternative interpretation is that the unit of time in the model is chosen so as to correspond to the maturity of debt at issuance, which implies that all debt is continuously rolled over. Dividing the left-hand and right-hand sides of equation (2) by *D* yields[1]:

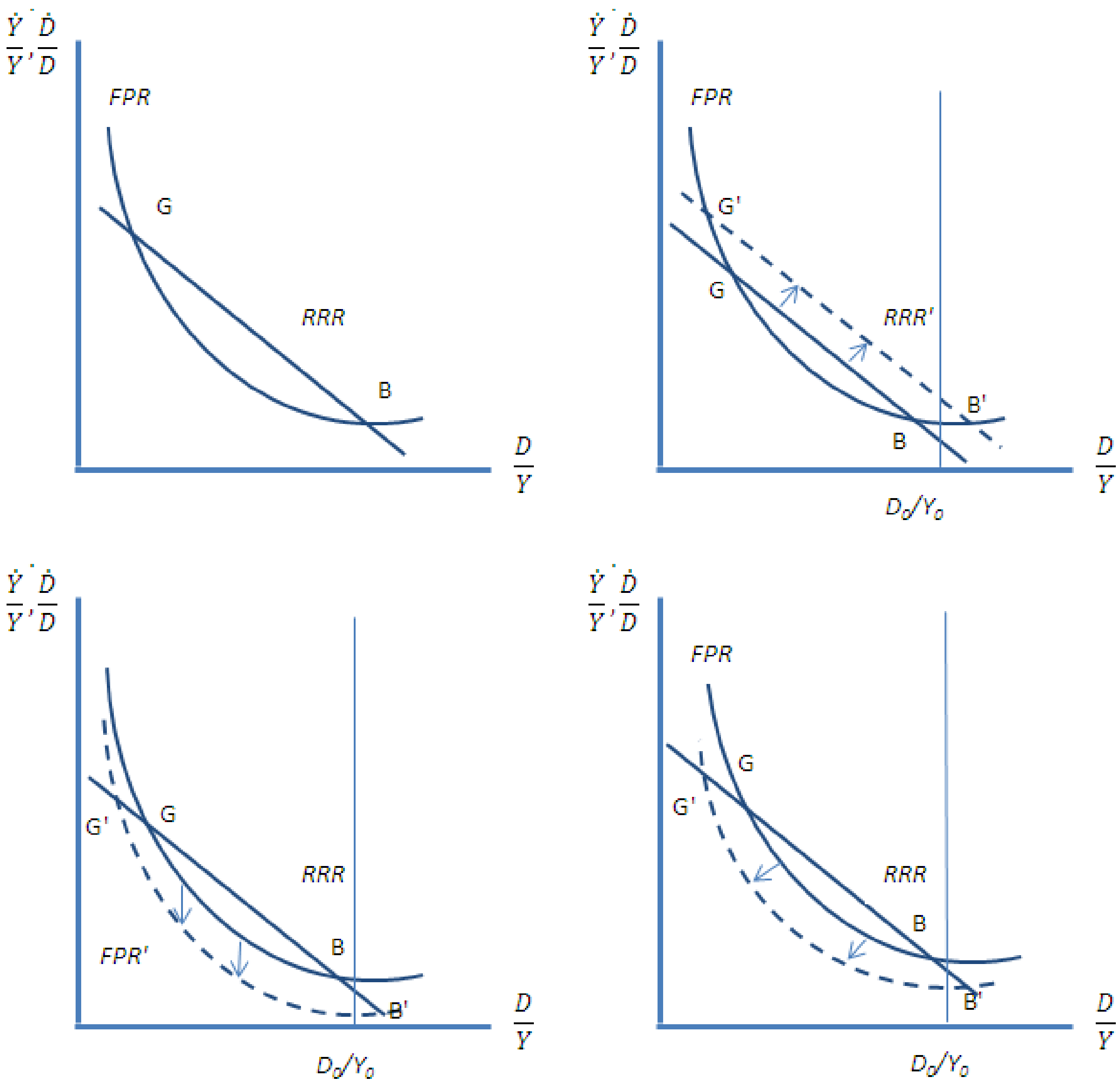
$$\frac{\dot{D}}{D} = r + \frac{p}{D/Y} \qquad (3)$$

This is the FPR schedule shown in the Figure 3, which for positive values of *p* takes the shape of a straightforward hyperbola. The intersections of the two curves represent the two possible equilibria of the model. *G* is a "good equilibrium" and *B* is a "bad equilibrium". In the region between *G* and *B* output grows faster than the debt level, so the debt ratio falls, and the economy tends to the good equilibrium with stable growth and the debt ratio corresponding to the point *G*. Similarly, left of point *G*, debt grows faster

1. For the sake of simplicity we omit in this specification the impact of other factors on changes in the stock of debt, such as revaluations, the purchase of sale of financial assets by the government, or default.

than output and the debt ratio increases until the equilibrium in *G* is reached. However, right of *B* debt grows faster than output and hence the debt ratio indefinitely increases while growth indefinitely falls. The bad equilibrium is unstable: the economy goes down the drain at ever faster rates.

Figure 3



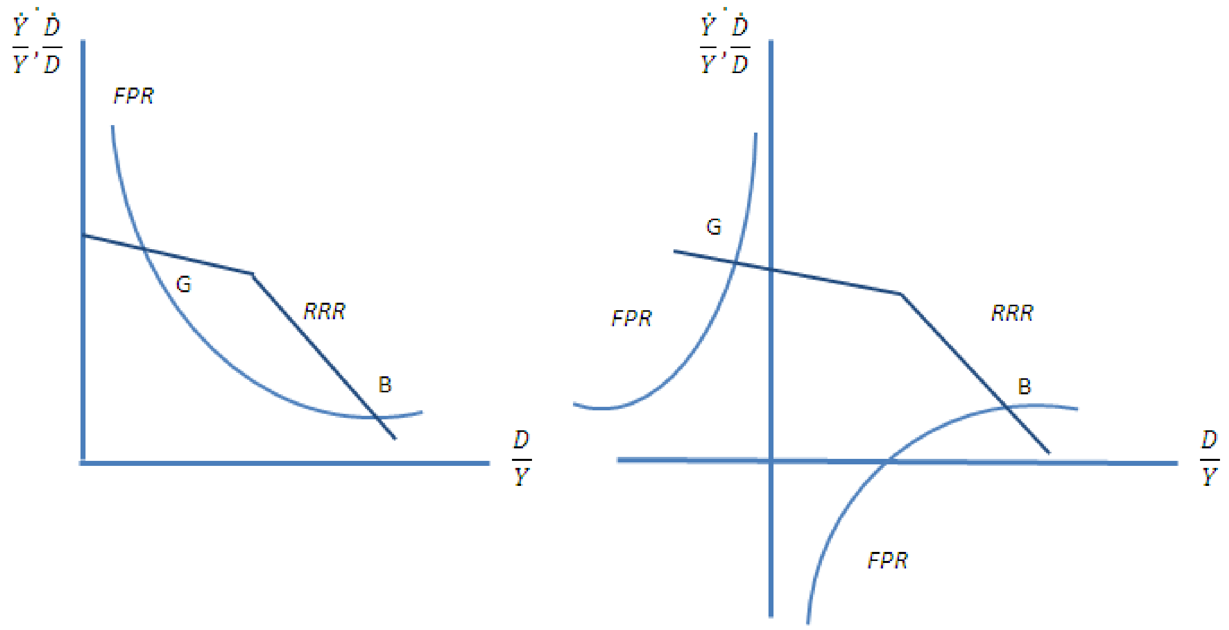
So, what kind of policies can help a country caught in a bad equilibrium to recover? Within the logic of this model there are three policy variables available: structural reform (a), fiscal policy (p) and the use of financial backstops to reduce the bond yield (r). As depicted in the upper-right panel of Figure 3, structural reform shifts the *RRR* schedule outward. As a result, a country whose debt ratio D_0/Y_0 was on an explosive path initially, will find itself left from the (now shifted) bad equilibrium *B'* and see its debt ratio fall and growth resume.

But obviously it takes time for structural reform to exert this virtuous effect on growth and debt, while time is severely lacking in a sovereign debt crisis. Moreover, for structural reform to produce this virtuous effect, confidence must be restored. Think for example of product market liberalisation that opens up new investment opportunities. Without confidence these opportunities for investment may be not taken up and so higher growth would not materialize. For confidence to be restored the budget must be brought under control immediately through credible fiscal consolidation while financial backstops can provide a "confidence bridge" (that however would not last indefinitely).

The lower-left panel of Figure 3 depicts how a fall in the interest rate supported by a financial backstop rotates the FPR schedule to the downward and thus achieves an immediate decline in the debt ratio and pushes the country left of the (now shifted) bad equilibrium *B*. Note that this will have only a limited impact on the good equilibrium which does not move much, because at very low levels of debt the interest rate matters less. The lower right panel shows what will happen in case of a once-and-for-all cut in the primary deficit, which shifts the FPR to the south-west. If fiscal consolidation helps to raise confidence and reduce the interest rate (the combined effects in both panels), the impact on the bad equilibrium will be particularly strong. Confidence provided by the financial backstop is only temporary: the new equilibrium *B'* could shift back to *B*. However the 'confidence bridge' can be used precisely to buy time, i.e. to allow for structural reforms to bear their fruits and raise the growth rate of the economy. Note also that the "confidence bridge" would allow to translate the investment opportunities opened up by, e.g. product market liberalisation, into effective investment as argued above. In other words short term and longer term policy measures would complement each other.

These findings can be easily formalised, but before we do so it is useful to point to four technical complications, although these do not change the basic properties of the model. The first complication is that the *RRR* schedule may be "kinked", in the sense that beyond a certain debt threshold the adverse impact of debt on growth will be stronger, as depicted in the left panel of Figure 4. This is a standard finding in the empirical literature following Reinhart and Rogoff's seminal paper, with the debt threshold generally found to be in the range of 80 to 90% of GDP (as will be discussed in more detail below). As noted, this does not change the basic features of the model, other than that the value of the parameter *b* in equation (2) would be conditional on the level of the debt ratio.

Figure 4



The second complication is that the primary fiscal deficit *p* takes a negative value in the case of a primary surplus. In that case the shape of the *FPR* schedule changes as depicted in the right-hand panel of Figure 4. The bad equilibrium preserves its basic feature, that is right from the intersection *B* the debt ratio explodes, but the nature of the good equilibrium is somewhat different. Left of the intersection *B* the economy is still stable as output grows faster than debt. However, the good equilibrium *G* is now located in the second quadrant, i.e. corresponds to a positive net asset position of the government. In the region between the good equilibrium *G* and the vertical axes, assets grow faster than output and hence the asset-to-GDP ratio increases. It will do so until the good equilibrium *G* is reached.

The third complication stems from the fact that for the sake of simplicity we have omitted in the budget constraint (3) the impact of other factors on changes in the stock of debt, such as the purchase or sale of financial assets by the government (for instance due to recapitalisations of distressed banks), which we will, however, consider in the dynamic simulations in section 5. A fourth complication is that the interest rate in the *FPR* schedule is actually a weighted average of past interest rates, embedded in the maturity structure of public debt.

Ignoring these complications for now, and assuming that the interest rate is exogenous (an assumption that will be relaxed in the next subsection) the steady-state debt burden (when debt and output grow at the same rate) can be derived from equating the *FPR* and *RRR* equations:

$$a - b\frac{D}{Y} = r + \frac{p}{D/Y} \qquad (4)$$

or

$$-b\left(\frac{D}{Y}\right)^2 + (a-r)\frac{D}{Y} - p = 0 \qquad (5)$$

This has two solutions:

$$\left(\frac{D}{Y}\right)^G = \frac{(a-r) - \sqrt{(a-r)^2 - 4bp}}{2b} \;; \qquad \left(\frac{D}{Y}\right)^B = \frac{(a-r) + \sqrt{(a-r)^2 - 4bp}}{2b} \qquad (6)$$

These are the solutions for respectively the good equilibrium *G* and the bad equilibrium *B*. For these solutions to be feasible it is necessary that the term under the root sign is positive. At the limit it could be zero in which case only one solution exists, which has a “bad” right side (debt ratio and growth derail of the equilibrium) and a “good” left side (debt ratio and growth stabilise left of the equilibrium). Whether or not these solutions are feasible is obviously an empirical question, which we will address below.

We will henceforth focus on the bad equilibrium and examine how policies could make it “shift to the right”, that is the bad equilibrium debt ratio corresponding to intersection *B* in Figure 3 shifts to the right. A shift to the right means that the debt ratio in the bad equilibrium increases, i.e. a country that initially was located right of *B* and derailing could now be stabilising and tending towards the good equilibrium *G* without a change in its actual debt ratio. So an increase in the debt ratio in the bad equilibrium is a favourable outcome and its decrease is an unfavourable outcome.

The graphical findings are generally confirmed. Specifically, we find that a positive growth shock gives a higher debt ratio in the bad equilibrium, hence the economy becomes more stable:

$$\partial\left(\frac{D}{Y}\right)^B / \partial a = \left(\frac{D}{Y}\right)^B \frac{1}{\sqrt{(a-r)^2 - 4bp}} > 0 \qquad (7)$$

By contrast, an increase in the primary deficit (a fiscal expansion) renders the economy more unstable and conversely fiscal consolidation makes it more stable:

$$\partial\left(\frac{D}{Y}\right)^B / \partial p = -\frac{1}{\sqrt{(a-r)^2 - 4bp}} < 0 \qquad (8)$$

An increase in the risk premium, finally, also makes the economy more unstable and vice versa for a cut in the risk premium through e.g. financial backstops:

$$\partial \left(\frac{D}{Y}\right)^B / \partial r = -\left(\frac{D}{Y}\right)^B \frac{1}{\sqrt{(a-r)^2 - 4bp}} < 0 \qquad (9)$$

So it is clear what a country in a bad equilibrium should do: it should implement structural reform to raise its growth rate (shifting the RRR schedule up), cut its primary deficit (shifting the FPR schedule to the left), and/or seek a cut in its (effective) interest rate (rotating the FPR schedule to the south-west). Moreover, initial conditions matter. The higher is the "bad equilibrium" debt ratio, the more effective are each of the policy instruments in moving it further outward. This implies that combining the three instruments in one package can mutually reinforce their effectiveness.

3.2 Adverse fiscal feedback loops and endogenous sovereign risk premia

While the findings in the preceding section are plausible, the model is too simple in at least two important respects. First, the interest rate is assumed to be exogenous, which is clearly unsatisfactory. It may be exogenous to some extent (a risk premium shock can come out of nowhere or spill over from other countries through "contagion"), but it may also respond endogenously to the public finances of the country concerned. Second, the model may put a too favourable gloss on the impact of fiscal consolidation. Fiscal consolidation (a cut in the primary deficit) may have adverse short-run effects on growth, which in turn may entail an adverse feedback effect on the debt ratio and the interest rate risk premium. Such a negative feedback loop is not included in the core model. We will therefore extend the model to take these channels into account and check how this would modify our assessment.

The augmented RRR now postulates growth to be a negative function of the (public) debt to GDP ratio *D/Y*, augmented with the of financial market conditions proxied by the interest rate *r* and the fiscal policy stance proxied by the primary deficit as a share of GDP *p*:[2]

$$\frac{\dot{Y}}{Y} = a - b\frac{D}{Y} - fr + gp \qquad (10)$$

2. We include the level rather than the change of the primary public deficit in this growth equation. This is consistent with the "Robertsonian saving" hypothesis embedded in Duesenberry's (1958) model. This hypothesis postulates that the next period's output is determined by the preceding period's income less net saving (S_n), so $Y_{t+1} = k(Y - S_n)$, where k is a constant. This implies that $\dot{Y}/Y = -k\,S_n/Y - (1-k)$, so it is the *level* of net saving as a share of output that determines the next period's output growth rate. Net saving can be broken down into public net saving as a share of output, i.e. the fiscal position, and private net saving as a share of output, which in turn may be assumed to be a function of the public debt ratio and the real interest rate as is implicit in equation (10).

We also assume that the interest rate responds to the growth in the debt ratio and (exogenous) contagion *h*. So:

$$r = h + c\left(\frac{\dot{D}}{D} - \frac{\dot{Y}}{Y}\right) \qquad (11)$$

Solving the model gives the following reduced forms (see annex):

$$\frac{\dot{Y}}{Y} = \frac{\left(a - b\frac{D}{Y} + gp\right)(1-c) - f\left(\frac{p}{D/Y}c + h\right)}{1 - c(1+f)} \qquad (12)$$

$$\frac{\dot{D}}{D} = \frac{h - ac + (1-cf)\frac{p}{D/Y} - c\left(gp - b\frac{D}{Y}\right)}{1 - c(1+f)} \qquad (13)$$

Equating the two gives:

$$-b\left(\frac{D}{Y}\right)^2 + [a + gp - (1+f)h]\frac{D}{Y} - p = 0 \qquad (14)$$

Which yields the following solution for the bad equilibrium *B*:

$$\left(\frac{D}{Y}\right)^B = \frac{[a + gp - (1+f)h] + \sqrt{[a + gp - (1+f)h]^2 - 4bp}}{2b} \qquad (15)$$

It is interesting to note that the parameter *c*, the semi-elasticity of the real bond yield with respect to the growth in the debt ratio, drops out of the equation. This implies that the adverse feedback loop from debt via the bond yield on growth does not operate via a change in the bad equilibrium itself but rather by influencing the pace of decline once the economy finds itself right of the bad equilibrium.

A positive growth shock again renders the economy more stable:

$$\partial\left(\frac{D}{Y}\right)^B / \partial a = \left(\frac{D}{Y}\right)^B \frac{1}{\sqrt{[a + gp - (1+f)h]^2 - 4bp}} > 0 \qquad (16)$$

Whether an increase in the primary deficit gives a lower bad equilibrium debt ratio (the economy becomes more unstable) or the reverse is now ambiguous and depends on the initial level of the bad equilibrium debt and on the fiscal demand multiplier g. When both are large, fiscal expansion (*p* increases) will have a favourable impact on the bad equilibrium i.e. it will shift the bad equilibrium to the right. This is the situation where the country is running a sustainable fiscal policy and a high fiscal multiplier and therefore has fiscal space available to effectively stimulate the economy through fiscal expansion. But if either of the two is small (fiscal impact on growth is small and the initial "bad equilibrium " debt level is small), fiscal expansion will exacerbate the instability (and conversely for fiscal tightening):

$$\partial\left(\frac{D}{Y}\right)^{B}/\partial p = \left[g\left(\frac{D}{Y}\right)^{B} - 1\right]\frac{1}{\sqrt{[a+gp-(1+f)h]^{2}-4bp}} \gtrless 0 \quad (17)$$

So, the term $g\left(\frac{D}{Y}\right)^{B} - 1$ could be nterpreted as a measure of fiscal space: the larger it is the more fiscal space is available,

A higher interest rate risk premium and contagion effects lower the bad equilibrium debt ratio and hence render the economy more unstable:

$$\partial\left(\frac{D}{Y}\right)^{B}/\partial h = -\left(\frac{D}{Y}\right)^{B}\frac{1+f}{\sqrt{[a+gp-(1+f)h]^{2}-4bp}} < 0 \quad (18)$$

So the main difference with the core version of the model is that the sign of the fiscal multiplier is now ambiguous and dependent on the initial conditions. If the initial conditions are benign (the bad equilibrium is located far to the right), fiscal expansion may exert a favourable impact on the stability of the economy. However, if the initial conditions are poor (the bad equilibrium is relatively low and hence located more to the left), fiscal expansion can make things worse. In that case, a combination of structural reform and fiscal consolidation would be a more appropriate policy mix. .

4. Panel estimation results

In this section we report our estimation results for the output growth equation (10) and the interest rate equation (11). The data for GDP growth, public debt, primary deficit, interest rates and control variables is obtained from the *OECD Economic Outlook* No. 90 database. Overall, the data set includes 34 OECD countries and spans over 52 years, from 1960 to 2011. However, the data series are not of equal length for all countries and variables. In the end, the estimation is done on a panel of 28 countries[3]. The sample is unbalanced, as for some countries the data goes back to the 1960s, whereas for others, mostly newer

3 . The countries included are Australia, Austria, Belgium, Canada, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Israel, Italy, Japan, Korea, Netherlands, Norway, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, Switzerland, United Kingdom and United States.

countries, it only goes back to the 2000s. The exact composition of the panel, however also depends on the estimation method, due do different use of lags.

Our aim is to obtain estimation of the "deep structural" values of parameters and multipliers that hold for an average OECD country in the last 30-40 years. Therefore, we purposefully use as broad a sample as possible, including all available data across countries and over time, not to make results too dependent on a specific economic period or a specific group of countries. Having an unbalanced panel may result in a sample bias, if characteristics of countries with a shorter series differ in a systematic way, but we nevertheless think that having a larger and longer sample brings about important benefits. In any case, in our empirical approach we at all times control for country fixed effects, taking much of this problem away. Moreover, when we test the robustness of our results to shortening the time period, the conclusions remain largely unaltered.

4.1 The growth equation

We estimate the following equation:

$$\bar{g}_{i,t+n} = \alpha + \beta_1 \frac{D_{i,t}}{Y_{i,t}} + \beta_2 M_{i,t;\,debt>T} * \left(\frac{D_{i,t}}{Y_{i,t}} - \mathrm{T}\right) + \gamma \frac{P_{i,t}}{Y_{i,t-1}} + \theta r_{i,t} + \delta' \mathrm{X}_{i,t} + \mu_i + \vartheta_t + \varepsilon_{i,t} \qquad (19)$$

where $\bar{g}_{i,t+n} = \frac{1}{n}\sum_{k=1}^{n} \frac{\dot{Y}_{i,t+k}}{Y_{i,t+k-1}}$, *i* denotes a country and *t* denotes time. All the main variables of interest are expressed in per cent or percentage points. The dependent variable $\bar{g}_{i,t+n}$ is a *n*-year forward overlapping moving average of annual real GDP growth rates, between year *t+1* and *t+n*. Varying the future time span allows us to distinguish between potentially differing short-term and medium/long-term effects of the explanatory variables on growth. We set *n* to *1, 3* and *5*. This approach also partly addresses the problem of endogeneity due to reverse causality and simultaneity between GDP growth, public debt and primary deficit. Whereas we claim that debt and primary deficit affect growth, it may also be the case that low growth leads to increases in public debt and primary deficit via automatic stabilisers and induced policy reactions. Therefore, by keeping the two policy variables at time *t* and moving growth rate forward in time, the endogeneity is weakened. Similar measures of growth have been used in Checherita and Rother (2010) and Cecchetti et al. (2011). The results reported in the next section rest on instrumental variables estimation so as to address any remaining endogeneity.

The term $\frac{D_{i,t}}{Y_{i,t}}$ in equation (19) represents public debt as a share of GDP, which in the third term on the right-hand side is interacted with a dummy variable *M*, indicating whether the public debt is above the threshold *T*. This recognises the fact, that the effect of debt on growth may be non-linear. In order to ensure that there is no discrete jump in the estimated regression line at the point where public debt equals the threshold, T is subtracted. This ensures that the growth equation is kinked like the one depicted in Figure 4. The $\frac{P_{i,t}}{Y_{i,t-1}}$ and $r_{i,t}$ measure the primary deficit as a share of (lagged)[4] GDP and the real long-term interest rate on government bonds, respectively. μ_i stands for country fixed effect and ϑ_t stands for time fixed effects.

Finally, $X_{i,t}$ stands for a vector of controls. Here we follow the growth regressions literature and include a standard set of controls, as for example reported in Barro and Sala-i-Martin (2004), to capture conditional convergence. Our approach differs from standard growth regressions in that we use GDP growth as opposed to per capita GDP growth as the dependent variable, in order to be consistent with the model in section 3. Controls in our case include: *inflation rate* to control for macroeconomic stability; the logarithm of the *initial GDP per capita,* to control for the catching up effect; *investment (gross capital formation) as share of GDP* as a proxy for capital formation; *mean years of schooling* to measure human capital; *trade openness* measured as sum of total exports and imports as share of GDP; *population growth* and the *dependency ratio* to control for the evolution of labour supply; and a *banking crisis indicator*, to control for potential negative effects on growth in years of banking crises as predicted by Reinhart and Rogoff (2009). The banking crisis variable is based on the data on systemic banking crisis constructed by Valencia and Laeven (2008 and 2010).[5] In constructing the banking crisis indicator we follow Cecchetti et al. (2011), meaning that it takes a value of zero if in the subsequent *n* years there is no banking crisis, and the value of *1/n*, *2/n*, and so forth, if a banking crisis occurs in one, two, etc, of the subsequent *n* years. The banking crisis indicator is hence the only regressor which is not predetermined with respect to the forward average growth rate.

Table 1 reports the estimation results for three different averages of future GDP growth rates: five year forward average, three year forward average and one year forward. In columns (2), (4) and (6) we report fixed effects results. Due to the overlapping nature of our dependent variable, the error term follows a moving-average process, therefore we use a robust procedure to compute the standard errors of our coefficient estimates; the standard errors are also clustered by country. Despite the future growth rate on

4 . To see why current primary deficit is taken as a share of lagged gdp, one should see that debt growth equation is derived from the expression $\dot{D}_t = r_t D_{t-1} + P_t$, dropping country index *i* for the moment. Now, dividing this by D_{t-1} and rearranging a bit, we obtain the expression that corresponds to the equation (3): $\frac{\dot{D}_t}{D_{t-1}} = r_t + \frac{P_t/Y_{t-1}}{D_{t-1}/Y_{t-1}}$.

5 . They "consider a banking crisis to be systemic if two conditions are met: 1) Significant signs of financial distress in the banking system (as indicated by significant bank runs, losses in the banking system, and bank liquidations); and 2) Significant banking policy intervention measures in response to significant losses in the banking system".

the left-hand side, there may still be endogeneity bias remaining, if growth rate and sovereign debt (or controls) are jointly determined by a third, omitted variable. Therefore, in columns (1), (3) and (5) we report the results from the instrumental variable GMM estimation, implemented in stata by the xtivreg2 of Schaffer (2010). This is also our preferred specification. To instrument for sovereign debt ratio and primary deficit ratio, we use their 1-3 period lags as instruments. Reported standard errors are robust to heteroskedasticity and autocorrelation of order 5, 3 or 2, in columns (1), (3) or (5), respectively.

The direction of the effects of public debt on growth is consistent with the model presented in section 3. Toward the bottom of the Table 1 we report the estimated threshold effect. This is the level of debt where the kink in the growth equation appears. The estimation procedure of the threshold follows Hansen (1999); for each specification we search over a grid of different thresholds to find the one that minimizes the residual sum of squares. We then take the estimated threshold effect as given, and use it to estimate the model. The estimated threshold effects in all cases are close to 90%, consistent with findings by other researchers. Reinhart and Rogoff (2010) find that for the level of debt ratio above 90%, average growth rate falls, whereas below that threshold, the relationship between government debt and GDP growth is weak. Point estimate for the threshold close to 90% for the effect of public debt on growth is also reported in Cecchetti et al. (2011) and Checherita and Rother (2010). Kumar and Woo (2010), on the other hand, consider two externally imposed thresholds at 30% and 90% debt levels, and they find that beyond the 90% level, debt becomes harmful to growth. The effect of government debt below the threshold is not statistically significant. Above the threshold, on the other hand, the effect becomes more negative and statistically significant.

Towards the bottom of the Table 1 we also report the total effect of debt on growth above the threshold. First, the negative effect of debt on growth becomes stronger over time, that is, the coefficient in column (5) is smaller in absolute value than coefficient in column (1). Increasing public debt by one percentage point this year will on average reduce GDP growth next year by 0.014 percentage points, whereas it will reduce the average annual growth over the next five years by 0.023 percentage points. In the medium term the effect of debt on growth is therefore almost twice as large.

The direction of the effects of the primary deficit and the interest rate on growth are also as expected. However, unlike the effect of debt on growth, the longer-run effects are generally weaker than the short-run effects/. Increasing the primary deficit as a share of lagged GDP by one percentage point this year, increases the growth rate by 0.087 percentage points in the next year, as reported in column (5). This goes down to 0.058 for the average growth rate in the next three years, column (3), and to 0.025 with no statistical significance over the next five years, column (1). In the same way, the real long-term sovereign interest rate has a stronger negative effect on growth in the short term as compared to the medium/long term.

Table 1: Estimated growth equations

	(1) GMM IV	(2) FE	(3) GMM IV	(4) FE	(5) GMM IV	(6) FE
Dependent variable:	five year forward average of gdp growth rate (%)		three year forward average of gdp growth rate (%)		one year forward of gdp growth rate (%)	
government debt/gdp (%)	-0.00230	-0.00174	0.000948	-0.00117	0.0117	0.00164
	(0.00493)	(0.00772)	(0.00552)	(0.00763)	(0.00714)	(0.00774)
government debt and threshold dummy - interaction	-0.0210**	-0.0234	-0.0231**	-0.0242*	-0.0260**	-0.0285***
	(0.00857)	(0.0137)	(0.00907)	(0.0127)	(0.0102)	(0.00935)
primary deficit/lagged gdp (%)	0.0247	0.0275	0.0582**	0.0519**	0.0872**	0.0349
	(0.0197)	(0.0196)	(0.0246)	(0.0236)	(0.0373)	(0.0284)
real long-term interest rate	-0.0559**	-0.0187	-0.111***	-0.0795**	-0.195***	-0.133**
	(0.0227)	(0.0246)	(0.0328)	(0.0377)	(0.0447)	(0.0534)
inflation rate (%)	-0.0517**	-0.0506	-0.124***	-0.110***	-0.251***	-0.210***
	(0.0224)	(0.0314)	(0.0277)	(0.0380)	(0.0422)	(0.0520)
log of gdp per capita	-8.737***	-8.172***	-8.572***	-7.878***	-6.701***	-6.365***
	(0.810)	(0.922)	(0.892)	(0.947)	(1.307)	(1.114)
gross fixed capital formation/gdp (%)	-0.0390*	-0.0456	-0.0380	-0.0559	0.0257	-0.0237
	(0.0224)	(0.0330)	(0.0277)	(0.0360)	(0.0427)	(0.0407)
mean years of schooling	0.00888	-0.0583	-0.223	-0.210	-0.463**	-0.384
	(0.194)	(0.253)	(0.197)	(0.243)	(0.229)	(0.226)
trade openness	0.0118	0.0159*	0.0173**	0.0202*	0.0303***	0.0228**
	(0.00731)	(0.00932)	(0.00778)	(0.0103)	(0.00956)	(0.0108)
population growth (%)	-0.110	-0.0284	-0.183	-0.174	-0.176	-0.100
	(0.228)	(0.226)	(0.251)	(0.257)	(0.293)	(0.278)
total dependency ratio	-0.0249	-0.0235	-0.0387*	-0.0366	-0.0336	-0.00935
	(0.0204)	(0.0246)	(0.0232)	(0.0253)	(0.0324)	(0.0250)
banking crisis indicator	-2.119***	-2.155***	-2.107***	-2.188***	-1.824***	-1.763***
	(0.361)	(0.486)	(0.385)	(0.476)	(0.467)	(0.504)
constant		149.2***		146.8***		120.4***
		(15.55)		(15.96)		(19.35)
country dummies	yes	yes	yes	yes	yes	yes
effect of government debt/gdp (%) – above threshold (p-value)	*-0.0233**** *(0.000392)*	*-0.0251*** *(0.0228)*	*-0.0221**** *(0.00122)*	*-0.0254*** *(0.0144)*	*-0.0143** *(0.0547)*	*-0.0269**** *(0.000290)*
Observations	590	649	646	705	702	761
Number of countries	28	28	28	28	28	28
R-squared	0.748	0.725	0.707	0.680	0.642	0.631
Debt threshold	93	92	89	90	87	87

*** p<0.01, ** p<0.05, * p<0.1. All regressions use country fixed effects. Instrumental variables in GMM IV regressions (columns (1), (3) and (5)) are 1-3 period lags of government debt ratio and primary deficit ratio. In GMM IV regressions the reported standard errors are robust to heteroskedasticity and autocorrelation of order 5, 3 or 2, in columns (1), (3) or (5), respectively. In fixed effects panel regressions (columns (2), (4) and (6)) the reported standard errors are robust to heteroskedasticity and adjusted for clusters by countries.

Table 1 also reports the results for the controls. The coefficient of the log of GDP per capita has a negative sign, implying the so called "catch-up" effect. Inflation rate also has a negative effect on GDP growth and trade openness has a positive effect, both as expected. A very strong and negative effect on growth comes from the banking crisis indicator. A banking crisis one year ahead is expected to reduce growth rate in that same year by about 1.8 percentage points, as reported in column (5). If the banking crisis persists, the effect on the average annual growth is even larger; over five years it amounts to a fall in average GDP growth of about 2.1 percentage points, as reported in column (1). The rest of the coefficients on controls are statistically not significant. The population (total dependency ratio and population growth) and education are slow moving variables, so perhaps in the fixed effects setting they do not have enough variation. Recall also, that in our case we use GDP growth on the left-hand side instead of per capita GDP growth, therefore, when we compare the coefficient on population growth with other growth regression estimations we should subtract 1 from our result. Doing so, we get somewhat closer to the results reported in Checherita and Rother (2010). The coefficient on investment (gross fixed capital formation) is also not statistically significant, but insignificant coefficients for this variable are reported in similar regressions also by Cecchetti et al. (2010) and Checherita and Rother (2010).

4.3 Interest rate equation

We estimate the following interest rate equation:

$$r_{i,t+1} = \sigma + \varphi\left(\frac{\dot{D}_{i,t}}{D_{i,t-1}} - \frac{\dot{Y}_{i,t}}{Y_{i,t-1}}\right) + \omega' \mathrm{W}_{i,t} + \mu_i + \vartheta_t + \epsilon_{i,t} \qquad (20)$$

where, the dependent variable $r_{i,t+1}$ measures the one year forward real long-term interest rate on government bonds, *i* denotes a country and *t* denotes time. μ_i and ϑ_t stand for country fixed effects and year dummies, respectively, and $\epsilon_{i,t}$ is the error term. Again, all the main variables are expressed in per cent or percentage points.

The second term on the right-hand side in equation 20 represents the growth rate of the debt to GDP ratio. As suggested in the theoretical section above, we would expect long term sovereign interest rate to increase when the debt dynamics worsen. We use the current debt dynamics to estimate the effect on the future interest rates. Moving the interest rate one year forward partly solves the problem of simultaneity, given that current interest rate can have quite a strong impact on current debt dynamics. However, as stressed also by Laubach (2009), it is the expectations of future debt dynamics that are important for determining the interest rate, and can also be used to circumvent the problem of endogeneity. He for example uses projections of fiscal variables several years into the future to estimate the interest rate equation.

However, to stick to the model as presented in section 3, we use the current level of debt growth. Expectations about the debt dynamics are thus incorporated into the country fixed effect and the error term. Of course, in this way the error term remains correlated with the debt growth term, therefore we again estimate the model using instrumental variable GMM estimation. The $W_{i,t}$ stands for the controls in equation 20. In choosing the controls we follow Laubach (2009) and Checherita et al. (2010) that estimate similar equations. The *real short term interest rate* controls for the effect of the monetary policy on long term interest rates, the *inflation rate* controls for macroeconomic stability and rises in prices, and the measure of *trade openness* allows for the open economy and controls for potential effects of openness on capital flows and interest rates.

Table 2: The effect of growth in sovereign debt on long term interest rates

	(1) GMM IV	(2) FE
Dependent variable: one year forward real long-term interest rate		
growth in government debt ratio (%)	0.0818***	0.0245**
	(0.0231)	(0.0109)
real short-term interest rate	0.169***	0.275***
	(0.0478)	(0.0867)
inflation rate (%)	-0.313***	-0.305***
	(0.0404)	(0.0668)
trade openness	0.0145	0.00431
	(0.0100)	(0.0127)
constant		2.308***
		(0.712)
country dummies	yes	yes
Observations	796	853
Number of countries	30	30
R-squared	0.586	0.610

*** p<0.01, ** p<0.05, * p<0.1. All regressions use country fixed effects. Instrumental variables in the GMM IV regression are 1-3 period lags of government debt ratio growth. The reported standard errors are robust to heteroskedasticity and autocorrelation of order 2 in column (1). In fixed effects panel regression (column (2)) the reported standard errors are robust to heteroskedasticity and adjusted for clusters by countries.

In Table 2 we report the results from the fixed effects panel estimation, column (2), and the instrumental variables GMM estimation, column (1), our preferred specification. Instrumental variables used in column (1) are the 1-3 period lags of government debt ratio growth. The reported standard errors are robust to heteroskedasticity and autocorrelation. The reported effect of the growth of government debt to GDP ratio is of a positive sign, as expected. In column (1) of Table 2, increase in debt growth by one percentage point, increases the next year real long term interest rate by 8.2 basis points. This effect is close to the effect estimated in Checherita et al. (2010) on a sample of European countries. Note, that the effect estimated with GMM IV is much stronger than the one estimated using fixed effects estimation, which suggests strong endogeneity of the debt growth variable. Turning to the controls, the real short term interest rate has a statistically significant positive effect on long term sovereign interest rates, whereas inflation rate has the expected negative effect. Coefficient on trade openness is not statistically significant.

5. Gauging the "bad equilibrium"

The econometric estimates reported in the previous section render allow us to identify the empirical values of the parameters in the theoretical model and subsequently compute the "good" and "bad" equilibrium debt levels and the multipliers developed in section 3 for the sample (comparative statics). In addition, we set up a discrete-time version of the model, with the empirical values of the model derived from the econometric estimates, and run shock and policy simulations with it (comparative dynamics).

5.1 Comparative statics

We derive estimates for the "good" and "bad" equilibrium debt ratios (corresponding to the points *G* and *B* in the graphs in section 3) and the multipliers for each of the policy variables *a*, *p* and *h* with respect to the bad equilibrium. Before we can do so, however, it is necessary to identify the parameter values from the estimation results. For this we take the GMM estimates based on one-period forward dependent variables.

Most parameter values can be directly inferred from the estimation results, with the exception of the "constant terms" a and h in, respectively, the growth and interest rate equations. These comprise the country-specific constant terms as well as the impact of the various control variables on growth and the interest rate, and hence vary across countries and over time. In addition we need to modify the theoretical model to capture the threshold effect of public debt on growth that came out significant in the econometric results in the previous section. Specifically, the relevant growth equation reads:

$$\frac{\dot{Y}}{Y} = a - b_1\frac{D}{Y} - b_2 M\left(\frac{D}{Y} - T\right) - fr + gp \qquad (10a)$$

where *M* is a dummy variable taking the value 1 if the debt ratio is above the threshold and zero otherwise and b_1 and b_2 represent the growth impact of the debt ratio, respectively, below and, for the interaction term, above the threshold. This equation can be re-written as:

$$\frac{\dot{Y}}{Y} = a' - (b_1 + b_2 M)\frac{D}{Y} - fr + gp \qquad (10b)$$

in which $a' = a + b_2 M \times T$. This gives us a properly adjusted estimate of the constant term in the equation.

The numerical parameters inferred from the estimation results, averaged for the whole sample in cases where these vary per country and/or over time, are reported in Table 3, including for the average primary deficit (*p*) which equals 0.3% of GDP. The resulting numerical estimated “bad equilibrium” debt ratio and multipliers are reported in Table 4. The sample average “bad equilibrium” debt ratio equals 106% of GDP, which implies that, on average, a country recording a debt ratio above 106% would see its debt ratio spiral out of control and its economy slump in the absence of offsetting policy action. Conversely, the “good equilibrium” to which the debt ratio tends if it is below the bad equilibrium threshold, turns out to be 75% of GDP. This means that if the debt ratio is in the 75% - 106% interval it would, on average, be falling towards 75% (and conversely increasing towards 75% if it is below that level). It should be stressed, however, that these numbers apply to the average of the sample as a whole and not necessarily to individual countries or sub-periods.

Table 3: Baseline parameters

a'	0.050	p	0.003
b_1	-0.012	f	0.195
b_2	0.026	g	0.087
c	0.169	h	0.027

Table 4: “Good” and “Bad” equilibrium and multipliers under different assumptions

	"Good equilibrium"	"Bad equilbrium"	Multipliers with respect to:		
			a	p	h
Baseline	75%	106%	9%	-8%	-11%
b_2 + 1 SE	75%	97%	5%	-5%	-6%
b_2 - 1 SE	75%	182%	32%	-15%	-39%
f + 1 SE	82%	94%	9%	-9%	0%
f - 1 SE	68%	116%	8%	-7%	-10%
g + 1 SE	74%	107%	9%	-7%	-11%
g - 1 SE	76%	105%	9%	-8%	-11%

Notes: SE indicates standard error on panel estimates of the parameters; multipliers measure the impact on the bad equilibrium debt ratio of 10 basis points (0.1 percentage point) changes of *a*, *p* or *h*.

The multiplier analysis in Table 4 shows that, again for the sample as a whole, structural reforms yielding an increase in economic growth of 0.1% per annum raises the “bad equilibrium” (i.e. moves out the point *B*) by 9 percentage point. Similarly, a sustained increase in the primary deficit as a share of GDP or a sustained increase (through e.g. stronger contagion effects) in the sovereign bond yield by 0.1 percentage point, reduces the bad equilibrium debt ratio by 8 and 11 percentage points, respectively. Importantly, expansionary fiscal policy renders the economy, on average, more unstable as the sign of the relevant multiplier is negative.

Table 4 also reports a sensitivity analysis for different assumptions with regard to the estimated model parameters. We have computed the impact of increases or decreases amounting to one standard error for several parameters. The most striking finding is the large sensitivity of the results to variations in the parameter value for b_2, the semi-elasticity of growth with respect to the debt ratio beyond the “Reinhart-Rogoff threshold” of 87%. This suggests that relatively small changes in the sensitivity of growth to debt can have a substantial impact on macroeconomic stability. This adds a dimension to the original Reinhart-Rogoff findings which focus on the impact of debt on trend growth whereas from our analysis also its impact on macroeconomic stability can be inferred.

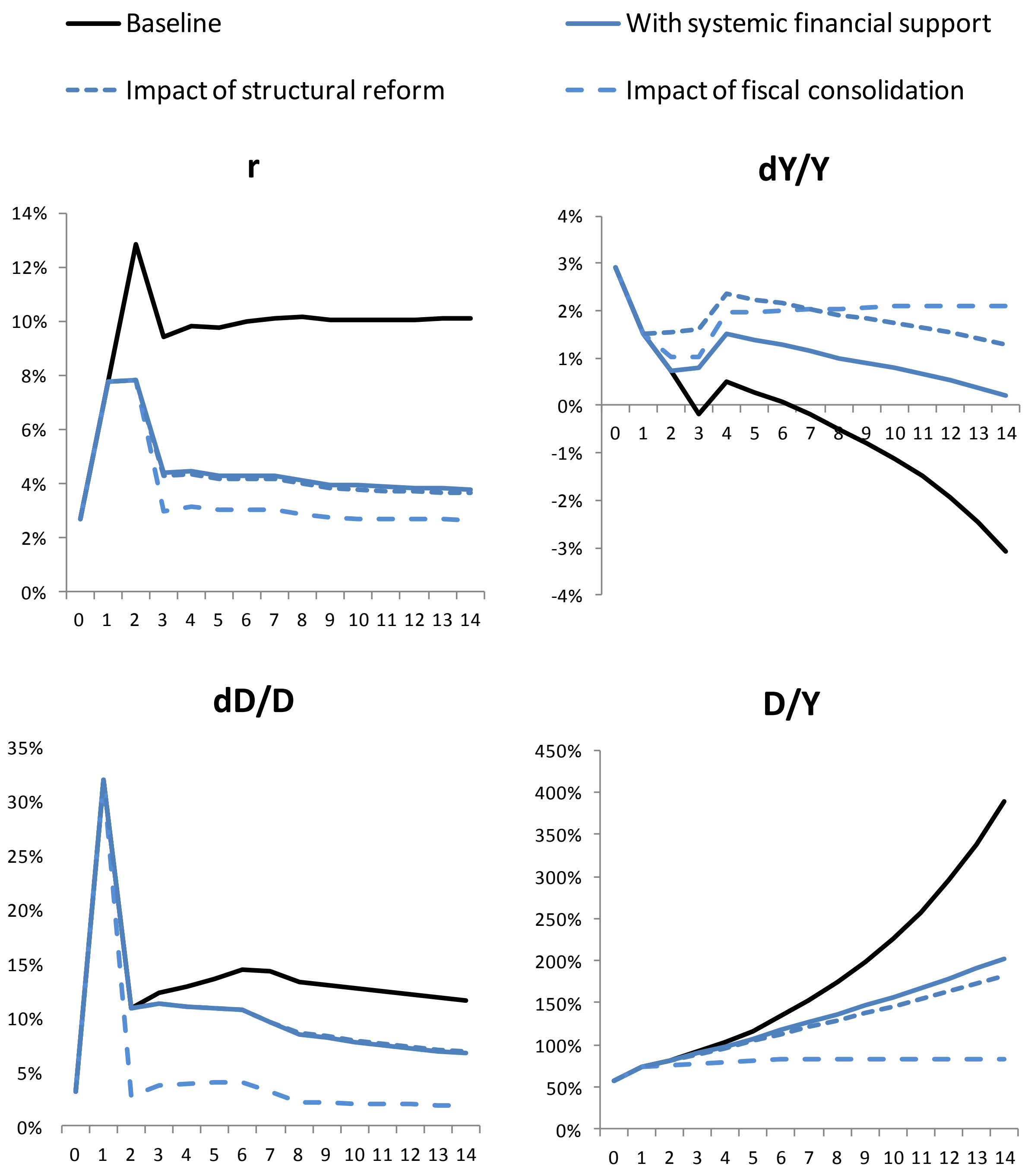
5.2 Comparative dynamics

The model can be used to carry out stylised dynamic simulations of policy impulse-responses. To do so, we first need to set up a baseline, which we have done in two steps. In a first step a simulation is run in which all initial values of the variables (debt ratio to GDP, primary fiscal deficit ratio to GDP and the “constant terms” *a* and *h* in the growth and interest rate equations) are fixed at their whole sample averages.[6] This yields, as expected, a debt to GDP ratio that tends to its “good equilibrium” of 75%.

In the second step, a combination of four exogenous shocks is simulated roughly replicating the impact of the financial crisis. These shocks are: (i) a once-and-for-all decline in economic growth of 1.8% in line with the impact of the “banking crisis” dummy in the growth regression; (ii) a one-off increase in the public debt ratio of 20 percentage points (to reflect the fiscal cost of bank rescues); (iii) a sustained increase in the primary deficit by 5 % of GDP; and (iv) a sustained increase in the real interest rate of 5%. This yields the baseline projection shown by the black solid lines in Figure 5.

6 . The effective interest rate on government debt is assumed to be equal to the five period moving average of the market yield.

Figure 5: Stylised dynamic simulation of policy measures

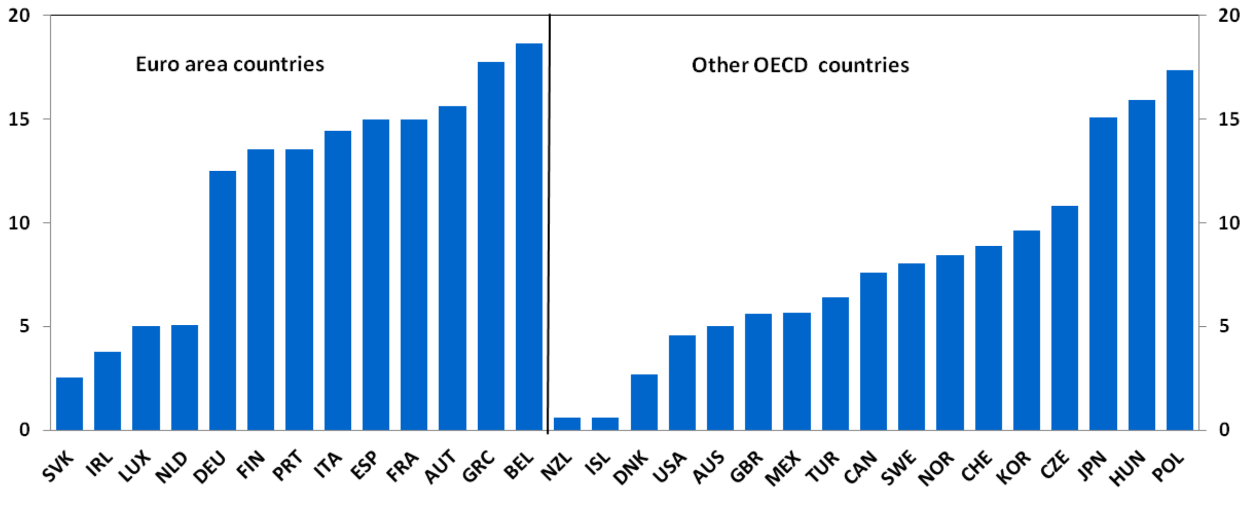


Under this baseline scenario public debt is clearly unsustainable, following an explosive path and attaining some 200% ten years after the crisis. Economic growth progressively declines and shows a continued and accelerating contraction after several years. As predicted by the theoretical model, the growth rate of real public debt converges to the real interest rate, which in turn stabilises at around 10%. Of course this simulation is stylised, even if the rough orders of magnitude of the shocks may be comparable to the observed developments.

On this baseline three policy shocks are superimposed. First, it is assumed that one year after the crisis has started financial support (e.g. purchases of sovereign bonds by the central bank, debt restructuring or mutualisation of debt) achieves to stop contagion and offset the impact of the crisis on the risk premium. This implies a sustained negative shock to *h* of 5%. As shown in Figure 5, this brings the real interest rate on a significantly lower path, but still implies an increase in the real interest rate relative to baseline due to the endogenous impact of the (growing) debt ratio. The growth of the debt ratio is roughly halved, but is still explosive. Output no longer contracts within the time horizon adopted for the simulation, but will eventually do so nonetheless.

Next, structural reform is assumed to be implemented one year after the crisis starts and to raise growth by ¾% per annum, *i.e.* the parameter *a* is increased by 0.75% on a sustained basis relative to baseline. This assumes both a strong effort and a large multiplier of structural reform, indeed close to the maximum attainable for a weighted average of the five distressed euro area countries based on recent estimates by the Bouis and Duval (2011). According to these estimates structural reform could raise potential output by 18%, 13%, 4%, 14% and 15% in, respectively, Greece, Portugal, Ireland, Italy and Spain over a period of 20 years (see Figure 6). This averages to 14% over 20 years for the five countries as a whole, or ¾% per annum. The time profile of the growth impulse is assumed to be flat, *i.e.* the short-run and medium-run impacts of structural reforms on the growth rate are assumed to be same, roughly in line with findings in Cacciatore et al. (2012).

Figure 6: Estimated cumulative impact of structural reforms on GDP, in per cent



Source: Bouis and Duval (2011).

Finally, fiscal consolidation is assumed to be implemented. This is not preset but calibrated so as to ensure that the public debt ratio stabilises within the simulation horizon. It turns out to be sufficient to cut the primary deficit by 6 percentage points of GDP in this stylised simulation. In that scenario the growth rate of real GDP stabilises as well (at around 2%). However, due to the negative demand impact of fiscal consolidation, output growth is initially lower than in the scenario without fiscal consolidation, although growth will eventually be higher (see the dotted line in the upper right panel of Figure 5). The upshot is that even with bold and successful structural reform and support for sovereign debt financing, substantial fiscal consolidation is needed. Indeed, while fiscal consolidation is found to produce headwinds for economic growth in the short-run, the simulations confirm that it is crucial for macroeconomic stability over the medium- to long-run. On the other hand, the more bang for the buck can be obtained from financial backstops and structural reforms, the less fiscal consolidation is needed to achieve a return to the good equilibrium.

6. Concluding remarks

In this paper we attempt to gauge the processes that trap countries in a “bad equilibrium” of high and growing fiscal deficits and debt, high risk premia and deep recession. For this we developed a simple analytical framework rooted in empirical evidence. We have it also to examine if and how a combination of structural reform and financial backstops can help to ease the burden on fiscal consolidation. From the analysis we infer the following two main conclusions.

First, our analysis confirms that the loss of fiscal policy space of countries in a bad equilibrium inevitably requires that fiscal action be directed towards consolidation, as reducing debt levels breed stronger growth and result in lower sovereign risk premia. It also confirms that fiscal consolidation initially may depress growth, but not to an extent where this would push a country into a bad equilibrium or prevent it from escaping from it. So, in a medium-term timeframe the trade-off between “austerity” and growth does not exist. However, in the very short-run it does, and this is complicating the political economy of fiscal consolidation. This is why it is particularly useful for countries in a bad equilibrium to be able to benefit from a “confidence bridge” through financial backstops.

Second, there is a very important role for structural reform to help countries escape from a bad equilibrium. Since the beginning of the crisis many countries have enacted structural reform in tandem with fiscal consolidation measures, which bodes well for the future. We find that a boost to growth through structural reforms may facilitate the exit from bad equilibrium. As in the case of fiscal consolidation, however, the positive impact on growth builds up over time, thus potentially giving rise to a political economy dilemma. Once again, financial backstops to engineer positive interest rate-debt-growth dynamics already in the short run may help economies to overcome the high-debt trap.

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MATHEMATICAL ANNEX

The structural model in section 3.2 reads:

$$\frac{\dot{Y}}{Y} = a - b\frac{D}{Y} - fr + gp$$

$$\frac{\dot{D}}{D} = r + \frac{p}{D/Y}$$

$$r = c\left(\frac{\dot{D}}{D} - \frac{\dot{Y}}{Y}\right) + h$$

The solution for the determinant is:

$$\begin{bmatrix} 1 & 0 & f \\ 0 & 1 & -1 \\ c & -c & 1 \end{bmatrix} \times \begin{bmatrix} \frac{\dot{Y}}{Y} \\ \frac{\dot{D}}{D} \\ r \end{bmatrix} = \begin{bmatrix} a - b\frac{D}{Y} + gp \\ \frac{p}{D/Y} \\ h \end{bmatrix}$$

$$\Delta = \begin{vmatrix} 1 & 0 & f \\ 0 & 1 & -1 \\ c & -c & 1 \end{vmatrix} = 1 - c(1+f)$$

The reduced form for the RRR can be derived from:

$$\Delta\frac{\dot{Y}}{Y} = \begin{vmatrix} a - b\frac{D}{Y} + gp & 0 & f \\ \frac{p}{D/Y} & 1 & -1 \\ h & -c & 1 \end{vmatrix} = \left(a - b\frac{D}{Y} + gp\right)(1-c) - f\left(\frac{p}{D/Y}c + h\right)$$

Hence:

$$\frac{\dot{Y}}{Y} = \frac{\left(a - b\frac{D}{Y} + gp\right)(1-c) - f\left(\frac{p}{D/Y}c + h\right)}{1 - c(1+f)}$$

The reduced form for the FPR can be derived from:

$$\Delta\frac{\dot{D}}{D} = \begin{vmatrix} 1 & a - b\frac{D}{Y} + gp & f \\ 0 & \frac{p}{D/Y} & -1 \\ c & h & 1 \end{vmatrix} = \frac{p}{D/Y} + h - c\left(a - b\frac{D}{Y} + gp + f\frac{p}{D/Y}\right)$$

Hence:

$$\frac{\dot{D}}{D} = \frac{h - ac + (1 - cf)\frac{p}{D/Y} - c\left(gp - b\frac{D}{Y}\right)}{1 - c(1+f)}$$