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**Abstract**

The unprecedented sovereign debt crisis across the European Monetary Union has prompted a new generation of models with "self-fulfilling" attacks to public debt. The key idea is that governments may be forced to default even though initial fundamental fiscal variables are sound. The model presented in this paper has two main features: (i) the government's default decision arises out of a cost-benefit analysis that sets the sustainable limit of the solvency primary balance; (ii) investors have no direct information about this variable, and are charaterized by a frequency distribution of "educated opinions". As a consequence, a "good" and "bad" state of the debt market are possibile; the latter is unstable and the model identifies an attraction domain of default within which the government is bound to default although initial solvency conditions are sustainable. A novel feature of the models is that the extent of this domain may be larger or smaller depending on the interplay between fiscal fundamentals and the *distribution* of investors' opinions. I then discuss several issues concerning the role of initial conditions, fiscal shocks, and the policy options to escape from the default domain. Under this new light, the institutional design of the European Monetary Union now appears seriously deficient and largely co-responsible for the gravity of the crisis.

Keywords: Models of public debt, speculative attacks, euro-soverign debt crisis

# 1. Introduction

(…) we are in a situation now where you have large parts of the euro area in what we call a "bad equilibrium", namely an equilibrium in which you may have self-fulfilling expectations that feed upon themselves and generate very adverse scenarios. So, there is a case for intervening, in a sense, to "break" these expectations (…) But then, we should not forget why countries have found themselves in a bad equilibrium to start with (Draghi (2012, p. 4)).

This quotation from the presentation of the new European Central Bank's (ECB) "Outright Market Transactions" programme for purchases of government bonds certifies the official endorsement of a new "multiple equilibria" (ME) approach to sovereign debt analysis. This approach marks a substantial modification of theory and policy with respect to the orthodox view of "market discipline" and "credibility", based on the efficient market hypothesis with single rational-expectations equilibrium.

Models of ME with "self-fulfilling prophecies" are a long-standing research field (e.g. Farmer (1993)). Financial and currency markets are natural fields where this class of models has proved able to yield valuable insights into complex phenomena such as bubbles, crashes, or speculative attacks. In fact, the closest antecedent to the ME approach to sovereign debt dates back to the various "generations" of models of currency crisis and exchange-rate regime collapse of the 1980s (e.g. Obstfeld (1995)). The study of sovereign debt crises in the ME approach also has forerunners in the 1980s (e.g. Calvo (1988)), but it is now being boosted by the dramatic euro-sovereign debt crisis that erupted in Greece in early 2009 and then propagated across the whole area.

This new wave of studies seeks to address, and explain in a consistent framework, a set of stylized facts that has rapidly grown to challenge the orthodox view traditionally endorsed by the European institutions (the relevant literature will be introduced where appropriate):

- there is scant evidence of consistent "market discipline", that is, the correct "fundamental" pricing of bonds, *throughout* the life of the euro: typically, (some) country risk spreads were too low until 2008; they have been too high since 2009
- except for the case of Greece, major debt crises in other member countries cannot be traced back to large and unsustainable pre-2008 fiscal imbalances, but rather to the systemic fiscal shock triggered by the 2008-09 world crisis
- there is evidence that post-2009 spreads do not reflect only country specific fundamentals, but are also highly sensitive to "systemic risk" and other exogenous factors

- there is evidence of "contagion", that is, the transmission of high spreads across countries via "non-fundamental" channels
- there is evidence of "self-fulfilling-prophecies" via the positive feedback mechanism among market beliefs of default, higher spread, higher fiscal effort, reinforcement of market beliefs
- so-called "austerity plans", fast up-front fiscal consolidation plans aimed at lowering spreads by way a greater "credibility", have proved to be self-defeating in almost all cases
- as a side, but obviously important effect, austerity plans have almost everywhere produced so-called "Keynesian effects", that is, a contraction of economic activity that makes fiscal consolidation harder and boosts the market beliefs of default.

A key feature of ME models of sovereign debt crisis is that fundamental fiscal variables and market beliefs interact, so that one equilibrium is typically a self-fulfilling default prophecy due to the positive feedback mechanism described above[1]. Hence, a sovereign may be driven to default even though it is solvent in initial conditions. This possibility has of course important policy implications both *ex ante* in the design of fiscal institutions and policy prescriptions, and *ex post* in the design of rescue systems. Under this new light, the institutional design of the European Monetary Union (EMU) now appears seriously deficient on both accounts and largely co-responsible for the gravity of the crisis.

Like ME models of currency crisis, also those of sovereign debt crisis now display different "generations". An earlier generation of models (e.g. Adrian and Gros (1999)) was concerned with the optimal choice of instruments whereby the government *can always remain solvent*, typically taxation or monetization (inflation). The current generation of models is concerned with institutional setups where the government is constrained in the use of these instruments (for instance, EMU governments have no access to monetization) and therefore *it can in fact opt for default* (e.g. Cooper (2012), Corsetti and Dedola (2011), Gros (2012), De Grauwe (2011)).

This paper presents a ME model of sovereign debt crisis belonging to this latter generation, which fits the EMU institutional features quite easily. Section 2 introduces the problem. Each "year" the government faces a solvency constraint in terms of a target primary balance, or "fiscal effort", that I call PB function, depending on the outstanding debt, its interest rate, and the nominal growth rate of GDP . The institutional setup is such that the government is constrained in the use of monetization. Therefore, compliance with the required fiscal effort entails higher taxation and/or

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[1] This phenomenon is also called "reflexivity" by Soros after Popper (Soros (2012)), or "strategic uncertainty" by Cooper (2012).

lower expenditure. These instruments are constrained, too, as they raise political-economic costs that are increasing in the fiscal effort. As an alternative, the government may opt for default, which is also a costly option. This cost-comparative analysis provides the first building block of the model, namely the threshold primary balance beyond which the cost of solvency exceeds that of default so that the government opts for default.

A key feature of the model is that the threshold of default is unknown to investors. These display a range of "educated opinions" about the threshold which can be represented in a relative frequency distribution. This feature distinguishes this model from the others which assume a single market belief or expectation. Section 3 models interest-rate determination as a risk premium over a risk-free rate. The critical variable that regulates the risk premium is the probability of default, given the target primary balance announced by the government. The probability of default is an "aggregate" (not individual) assessment of the market, defined as the cumulated frequency of the investors who believe that the target primary balance exceeds the default threshold. As a result, I obtain an interest-rate function IR depending on the risk-free rate and the target primary balance via probability of default, which is in turn sensitive to *the first two moments* of the frequency distribution of investors' opinion.

The two functions can generate two non-default equilibria, a "good equilibrium" (stable) with low fiscal effort and interest rate, and a "bad equilibrium" (unstable) with high fiscal effort and interest rate. Both equilibria are a joint product of fiscal fundamentals (the PB function) and market opinions (the IR function). This system also identifies two domains of attraction separated by the bad equilibrium: one of the good equilibrium, one of the default. This means that if the government finds itself outside the good-equilibrium domain, it is bound to default irrespective of sustainable initial conditions. The extension of the domains crucially depends on the first two moments of the distribution of opinions; in this respect, the present model disputes Gros's (2011) conclusion that uncertainty about default makes ME less likely and reduces their range. Section 3 is completed with a discussion of insights of the model regarding seemingly inexplicable differences in risk premia (over time and across countries), the role of fundamentals vs. non-fundamentals, contagion, and foreign debt vs. domestic debt.

Section 4 is devoted to policy implications. In particular, how to escape from the default domain. The aim of this section is not to provide detailed policy solutions or examine those under discussion in the EMU, but only to show how the model can be used to frame policy analysis. In this respect, the model highlights an important difference between the "credibility" approach and the "sustainability" approach. From this ensues an explanation as to why austerity may not work and may indeed be the wrong policy in the default domain. It is also pointed out where the main faults lie in the EMU design regarding *ex-ante* protections and *ex-post* rescue systems.

## 2. Assessing a sovereign's insolvency

Assessing a sovereign's ability to service its debt is not an easy task, for reasons that extend beyond the technicalities of complex financial entities. The first point, an oft-forgotten one, is that a sovereign, unlike any other ordinary debtor, has, by definition of "sovereign", the power to manipulate its balance sheet so that its debt can always be serviced. In simple words, a sovereign is virtually ever solvent. In practice, a sovereign may be, or assessed to be, insolvent only because some constraints are imposed, or self-imposed, on its powers. However, by their very nature, such constraints can be tightened or relaxed as a result of institutional circumstances and, eventually, political decisions. Therefore, the essential difficulty in assessing the likelihood of a sovereign's insolvency lies in its *political dimension,* which is a source of peculiar, extra-economic, uncertainty not amenable to firm "objective" analysis of the so-called "fundamentals".

### 2.1. Basic notions

To begin with, let us examine the evolution of the sovereign's debt[2] over time in a forward-looking perspective from the current year $t$. Hence, the money value of the level of debt in $t$+1 $D_{t+1}$ will be

(1) $D_{t+1} = D_t + (i_{t+1}D_t - B_{t+1}) - M_{t+1} + S_{t+1}$

that is to say, the value of outstanding debt in $t$ $D_t$ plus the government's net borrowing requirement (in brackets), minus central bank's loans ("monetization" for short, $M_{t+1}$), plus extraordinary debt-management operations (e.g. asset sales, $S_{t+1} < 0$) and other corrections (often called "stock-flow adjustments", see e.g. European Commission (2011)).[3] The government's net borrowing requirement in $t$+1 will result from the difference between interest payments on the outstanding debt and the primary balance $B_{t+1}$. In this formulation, given $D_t$, the evolution of debt

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[2] Debt held by the resident and non-resident private sector. Excluded is the debt held by other public institutions, namely the central bank. In fact, interests paid on the latter share of debt do not constitute net disbursements for the public sector as a whole.

[3] Monetization may take many different forms. Analytically, $M_{t+1} > 0$ denotes direct purchases of bonds in the issuance market. Purchases in the secondary market are better represented as if $S_{t+1} < 0$, since they move a fraction of the outstanding debt out of the private sector (see fn. 2).

entirely depends on the future variables $i_{t+1}$, $B_{t+1}$, $M_{t+1}$, $S_{t+1}$. These may be matter of government's forecast and planning as well as of creditors' assessment.

The key variable in government's planning is usually $B_{t+1}$. For instance a typical "Fiscal-Compact-style" plan in the EMU consists of planning $B_{t+1}$ so as to achieve a given debt target in $t$+1. Let this be $D^*_{t+1}$; therefore

(2) $B^*_{t+1} = -\Delta D^*_{t+1} + i_{t+1}D_t - M_{t+1} + S_{t+1}$

where $\Delta D^*_{t+1} \equiv D^*_{t+1} - D_t$ is the target in terms of debt change. Suppose $D^*_{t+1} < D_t$ , that is, the government plans to reduce its debt by $\Delta D^*_{t+1} < 0$. This target *per se* implies a primary surplus, or "fiscal effort" $B^*_{t+1} = -\Delta D^*_{t+1} > 0$. It is convenient to expand the primary balance into its two main components, total expenditure in goods and services $G_{t+1}$ and total fiscal revenue $T_{t+1}$. Hence,

(3) $T_{t+1} - G_{t+1} = -\Delta D^*_{t+1} + i_{t+1}D_t - M_{t+1} + S_{t+1}$

We are now in a position to appreciate the special status of a sovereign. In this expression there are two variables that a sovereign, and only a sovereign, can control at will in order to achieve any target $\Delta D^*_{t+1}$. One is its fiscal revenue $T_{t+1}$, and the other is monetization $M_{t+1}$. In fact, by imposing taxation, a sovereign can raise its revenues, while by monetization it can expand its ability to pay in ways that are precluded to any other ordinary debtor. To some extent also $S_{t+1}$ can be manipulated by way of legislation, as is the case with forced debt redemption. Therefore, for any target $\Delta D^*_{t+1}$, or any associated solvency constraint, a sovereign can always *choose* the appropriate combination of $T_{t+1}$, $G_{t+1}$, $M_{t+1}$, $S_{t+1}$ that satisfies the target or the constraint.[4]

To keep the treatment manageable, I will consider the minimal solvency requirement of "no Ponzi game", or no Minsky's "ultraspeculative position", that is, no new debt to pay interests on outstanding debt. This amounts to setting $\Delta D^*_{t+1} = 0$, or keeping the total budget in balance.

Where does a sovereign's solvency problem come from? As stated above, it may come from constraints imposed, or self-imposed, on its ability to manipulate $T_{t+1}$, $G_{t+1}$, $M_{t+1}$, $S_{t+1}$ at will.

## 2.2. The role of GDP and GDP ratios

Country debt data are usually presented as GDP ratios (EMU fiscal rules are stated in this way), and such ratios also appear in assessment reports of specialized agencies. This form of debt accounting – which has several drawbacks – is nonetheless a good way to introduce the problem of the limits to the sovereign's manipulation of its solvency constraint. Let us

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[4] The same applies if we expand equation (3) into the usual net present value formulation of the intertemporal primary budget constraint (e.g. Buiter (2012b)).

consider the fiscal-effort equation (3) under the given target $\Delta D^*_{t+1} = 0$. The total fiscal revenue is clearly determined by the economy's year GDP $Y_{t+1}$, given the average tax rate $\tau_{t+1}$, i.e. $T_{t+1} = \tau_{t+1} Y_{t+1}$. This sets the economy's ability to pay for the debt. We can now divide both sides of the equation by $Y_{t+1}$. Note that $Y_{t+1} = (1 + n_{t+1})Y_t$, where $n_{t+1}$ is the one-year nominal growth rate. This can be split into an invariant trend component $n$, and a time-variant shock component $z_{t+1}$ Hence, denoting GDP ratios with small-case letters, we obtain

(4) $$\tau_{t+1} - g_{t+1} = \frac{i_{t+1}}{(1+n)(1+z_{i+1})} d_t - m_{t+1} + s_{t+1}$$

Let us examine the sovereign's choice variables in turn. First comes the average tax rate $\tau_{t+1}$. Given all the other variables, the government in principle can set whatever $\tau_{t+1}$ that is necessary to solve the constraint. However, the expression in terms of GDP ratios highlights that the government may face a constraint on the size of $\tau$ given by the economy's ability, and willingness, to sustain taxation. Increasing $\tau$ may trigger various negative feedbacks, such as (i) a fall in $n_{t+1}$, (ii) an increase in tax evasion (so that the actual fiscal revenue is less than planned), (iii) the loss of political majority. Alternatively, the government can set $g$, taking all other variables as given. Yet cutting $g$ may also encounter limits analogous to those on $\tau$.

These considerations entail the thorny issue of the relationship between the fiscal variables and economic activity. The idea itself that governments perceive a constraint in the use of fiscal variables implies that a *negative* relation should exist (this is present for instance in the models of Calvo (1988), Corsetti and Dedola (2011), Gros (2012)). However, the literature on so-called "non-Keynesian effects" argues that such a relation is negligible or even *positive* if fiscal restriction is operated through expenditure cuts rather than tax increases (Giavazzi and Pagano (1996), Alesina and Perotti (1997)). In the current empirical research "Keynesian effects" seem to prevail (e.g. Coenen et al. (2010), Burriel et al. (2011), Perotti (2011)). Given this uncertainty, and the ensuing analytical complexity, I shall not model the fiscal effects on economic activity explicitly. It should also be pointed out that, as will be seen, the existence of ME and the main features of this model do not depend on these effects. However, they can be easily accommodated geometrically as shocks $z_{t+1}$ that deviate the nominal growth rate from trend (see par. 3.5)[5].

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[5] Fiscal effects may concern real growth as well as inflation. A model of debt dynamics with Keynesian effects of nominal growth is presented by Tamborini (2011)

Then the government may consider monetization $m_{t+1}$. Here the problem is notoriously thorny. The main economic counter-argument is that monetization triggers inflation, at least in the long run. Yet, as shown by equation (4), this is not necessarily bad news since inflation inflates $n$ and hence reduces the fiscal effort for the economy. On the other hand, high inflation may reduce the real growth component of $n$. Hence a trade-off may exist for the representative voter between more inflation and less fiscal effort, especially if inflation arises in the future whereas fiscal effort bites in the present. This trade-off lies at the core of the "first generation" models that examine the optimal mix between real and inflation tax to service the debt (e.g. Adrian and Gros (1999)).

Beyond strict economic considerations, monetization involves a major institutional dimension, since in developed modern systems the fiscal and the monetary authorities are different entities, and the government may have little control (if any) on $m$ depending on the degree of independence of the central bank. The emblematic case is that of EMU members, which face the institutional constraint $m = 0$. Eventually, the government may resort to large extraordinary operations $s_{t+1} < 0$. Economically, these may be of uncertain amount, while forced debt operations may encounter political limits, and may exhibit the trade-off with future inability to borrow.

Interestingly, the extended studies by Reinhart and Rogoff (2009) on historical public debt crises show that major solvency problems were resolved by a combination of monetization, inflation and extraordinary operations (often concomitantly with major external events such as wars, revolutions, and political changes). However, even our sketchy overview of the options of a sovereign debtor shows that its virtually unlimited ability to service its debt may in practice be constrained by economic or extra-economic factors, which are the focal point of the present "second generation" of public debt models. In fact, today the "orthodox" debt-management polices that democratic governments are expected to abide with prescribe that $m$ and $s$ should be small or zero. Nonetheless, the main point holds that assessing a sovereign's solvency involves political and institutional dimensions that generate a particular form of uncertainty to which we shall turn in the subsequent sections.

## 3. The model

### 3.1. The default decision

I first introduce the sovereign's default decision. There are many models of this decision, usually based on the optimization of some objective function of the government. For present purposes, we do not need a detailed model.

The key point, as explained above, is that this decision is not uniquely dictated by "objective" financial factors, but it essentially depends on the comparative costs or benefits of the various solvency instruments that the sovereign faces. Also, default may in practice take a variety of forms and extensions; these technicalities would complexify the analysis in a substantial way, and I shall keep them to a minimum.

It is convenient to focus on the fact that, in the face of fiscal distress, all policy options are costly[6]. To begin with, let us consider the fiscal effort given by the primary-surplus/GDP ratio $b^*_{t+1}$ in the solvency equation (4).[7] Compliance with this target represents a cost – political, economic, etc. – for the government which is natural to assume to be increasing and convex in $b^*_{t+1}$, $C(b^*_{t+1}) > 0$, $C'(b^*_{t+1}) > 0$, $C''(b^*_{t+1}) \geq 0$. On the other hand, the government also perceives costs from non-compliance and default, essentially in the form of reputation loss towards electors and creditors that may thwart future re-election and access to borrowing. These costs are likely to be perceived as independent of the size of the budget (debt), $D(b^*_{t+1}) > 0$, $D'(b^*_{t+1}) = 0$, as well as of the size of default or of other technicalities[8]. This comparative-cost framework is sufficient to obtain a default rule, i.e. $\min(C(b^*_{t+1}), D(b^*_{t+1}))$. In fact, there exists a single value $\bar{b}$ such that (i) $C(\bar{b}) = D(\bar{b})$, and (ii) $C(b^*_{t+1}) \gtrless D(b^*_{t+1})$ for any $b^*_{t+1} \gtrless \bar{b}$. Hence the government will comply with the solvency constraint only up to the threshold fiscal effort $\bar{b}$ beyond which the cost of solvency exceeds the cost of default. Note that $\bar{b}$ is increasing in $D$ and decreasing in $C$.

A crucial point of the present model is that this threshold cannot be assessed with certainty by investors, for two reasons. The first is that $\bar{b}$ is the result of government's preferences, information and other decision inputs which are typically not accessible to external subjects. The second is that $b^*_{t+1}$ may, at least to some extent, be manipulated by the government as explained previously. For instance, the constraint $m = 0$ may not be as tight as stipulated in laws and statutes; and even independent central banks may negotiate to buy sovereign bonds under some circumstances or for monetary policy purposes (Buiter (2012b)).

For completeness, it should also be borne in mind that in reality the government's options include not only solvency/default but also partial fiscal

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[6] De Grauwe (2011) treats them in terms of benefits, which is obvioulsy specular. I find cost comparison more straightforward.

[7] Calvo (1988) and Corsetti and Dedola (2011) also focus on the primary balance or its components. Other models instead consider the debt stock directly (e.g. Gros (2012), Cooper (2012)). But $b^*_{t+1}$ is in fact related to $d_t$.

[8] Gros (2012) presents a model where the size of default, controlled by the "haircut" rate imposed on creditors, is a choice variable.

effort, that is, a primary surplus $b_{t+1} < b^*_{t+1}$. In this (frequent) case, the consequence is usually not immediate default, but rather an increase in outstanding debt at a higher interest rate that defers either full solvency with greater fiscal effort or default. This entails an intertemporal cost assessment that I will not consider here. However, the model can also accommodate temporary deviations from solvency, as will be seen in due time.

**3.2. Probability of default and sovereign risk premium**

I now move to the investors' side and introduce a simple model of sovereign risk premium leading to the determination of the interest rate on outstanding debt.

As explained above, investors operate under uncertainty about the sovereign's default; hence the key variable is some measure of the probability of default $p$, which I shall analyze below. Default consists of two measures: (i) cessation of interest payments, (ii) a possible percentage $h$ of "haircut" on outstanding capital. A particular form of haircut, to which we shall return later, affects foreign investors by way of devaluation of the denomination currency of the debt. Investors are risk-neutral and have access to an alternative safe asset yielding a constant return $\bar{i}$. Consequently, for each unit of capital, arbitrage will determine

$$(1 + i_{t+1})(1 - p) + (1 - h)p = 1 + \bar{i}$$

and

$$i_{t+1} = \frac{\bar{i} + hp}{1 - p} \qquad (5)$$

Note that, as commonly expected, $i_{t+1}$ is increasing in $p$ and $h$.

The default probability in this framework is best conceived as a quantitative assessment of investors' conjecture as of $t$ whether $b^*_{t+1}$ will exceed $\bar{b}$. To this end let us first assume that this conjecture is based on the prior information that $m_{t+1} = s_{t+1} = 0$, so that $b^*_{t+1}$ is common knowledge according to equation (4).

Since $p$ is gauged on a conjectural basis, it may also differ across investors. This is in fact an important feature of sovereigns' default assessment (for instance, the ratings of specialized agencies often differ), which is however absent from other ME models where "the market" is treated as a single representative agent. In order to capture this feature and quantify *p at the market level*, imagine that we have the investors' opinion poll about the level of $\bar{b}$ so that we can construct the relative frequency distribution of such opinions. For $N$ revealed opinions $\bar{b}_n$ with relative frequency $f_n$, the market opinion is $\bar{b}_M = \Sigma_n \bar{b}_n f_n$. In a cross-sectional application of the rational expectations hypothesis, we may well posit that

$\bar{b}_M = \bar{b}$ – i.e. the market is right as opinion aggregator. But what does matter for interest-rate determination is the frequency distribution of opinions. Given $b^*_{t+1}$, a consistent representation of the market probability of the default event is the cumulated frequency of the subset of individual opinions $d \in N$ such that $\bar{b}_d \leq b^*_{t+1}$, i.e. $p = \Sigma_d f_d$ . A feature of cumulated frequency is that it increases with $b^*_{t+1}$, so that we can posit $p(b^*_{t+1}) \in [0, 1]$, $p'(b^*_{t+1}) > 0$. According to equation (5), also $i_{t+1}$ will be increasing in $b^*_{t+1}$.

Table 1 provides a numerical example of a frequency distribution of investors' opinions about $\bar{b}$ . It portrays a likely situation in which opinions have a bell-shaped distribution: that is, they differ but are concentrated on a range of values, namely between 6% and 8%. The market opinion about $\bar{b}$ is $\bar{b}_M = 6.7\%$. The last two columns show how the market default probability $p$ is associated with given values of $b^*_{t+1}$. For $b^*_{t+1} = 3\%$ $p$ is very small, but as $b^*_{t+1}$ increases towards the central value of the distribution of opinions, $p$ increases substantially.

**Table 1. A numerical example of the frequency distribution of investors' opinions about $\bar{b}$**

| $\bar{b}_n$ | $f_n$ | $\bar{b}_n \times f_n$ | $b^*_{t+1}$ | $p$ |
|---|---|---|---|---|
| 3.0% | 1.0% | 0.03% | 3.0% | 1.0% |
| 4.0% | 3.0% | 0.12% | 4.0% | 4.0% |
| 5.0% | 11.0% | 0.55% | 5.0% | 15.0% |
| 6.0% | 25.0% | 1.50% | 6.0% | 40.0% |
| 7.0% | 35.0% | 2.45% | 7.0% | 75.0% |
| 8.0% | 21.0% | 1.68% | 8.0% | 96.0% |
| 9.0% | 4.0% | 0.36% | | |
| Σ | 100.0% | 6.69% | | |

An interesting feature to be noted is the following. When $b^*_{t+1}$ approaches the market opinion $\bar{b}_M$ , $p$ is not 1. Not even if $\bar{b}_M = \bar{b}$ . This is a consequence of the dispersion of opinions, so that "the market" is never certain of the default event (except for extreme tail values of $b^*_{t+1}$). This feature reproduces the observed fact that interest rates on sovereign debts do increase at news on a worse fiscal outlook, but they do not just jump from $i_0$ to infinity as it would happen in equation (5) if all investors held the same opinion about $\bar{b}$ .

### 3.3. "Good" and "bad" equilibria

The gist of the previous treatment consists of three elements: (i) the government's threshold value of the primary balance $\bar{b}$ that triggers the default decision, (ii) the equation that gives the solvency primary balance (PB)

(6) $$b^*_{t+1} = \frac{d_t}{1+n_{t+1}} i_{t+1}$$

and (iii) the equation that determines the interest rate on outstanding debt (IR)

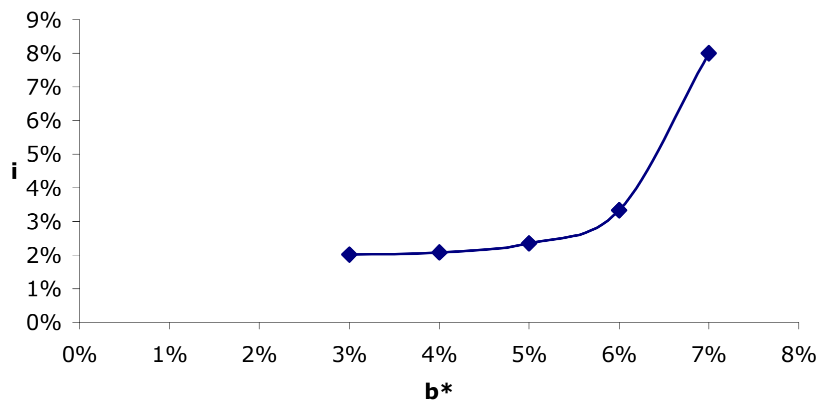
(7) $$i_{t+1} = \frac{\bar{i} + hp(b^*_{t+1})}{1 - p(b^*_{t+1})}$$

The key feature of the model is that $b^*_{t+1}$ and $i_{t+1}$ are interdependent via the market probability of default $p$. Given the properties of the function $p(b^*_{t+1})$, the result is a positive feedback mechanism such that the higher is $b^*_{t+1}$, the higher is $i_{t+1}$, and so forth. Positive feedback mechanisms are typical generators of instability, multiple equilibria, "self-fulfilling prophecies", etc. The present model is no exception.

The PB equation is linear in $i_{t+1}$ with slope determined by outstanding debt $d_t$ (which increases the slope) and nominal growth $n_{t+1}$ (which decreases the slope). As long as actual primary balances fulfil the PB equation, the outstanding debt remains constant (if the government misses the target, this can be treated as a shock to $d$: see below, par. 3.5).

Let us now examine the IR equation. Given $i_0$ and $h$, its shape depends on the function $p(b^*_{t+1})$, that is, on the frequency distribution of the investors' opinions. The plot of the IR function with the data in Table 1 and $\bar{i}$ = 2%, $h$ = 0 is reproduced below for reference (for notational simplicity the time subscript is dropped).

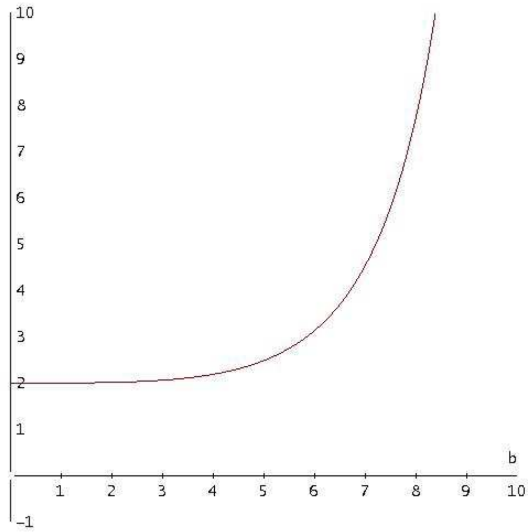
**Figure 1. The IR function with the data in Table 1, $\bar{i}$ = 2% and $h$ = 0**




As explained above, this is a case where opinions are relatively concentrated around the true value of $\bar{b}$; hence $p(b^*_{t+1})$ and $i_{t+1}$ increase faster as $b^*_{t+1}$

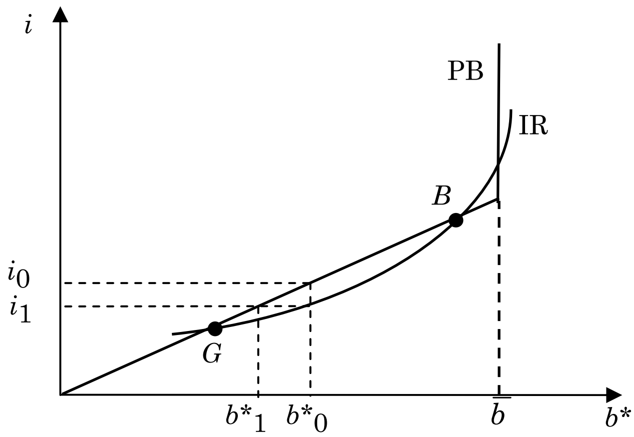
approaches and then exceeds $\bar{b}$ . This kind of plot is obtained more generally for common distributions like the Normal or the Uniform.

**Figure 2. The IR function with a continuous Normal distribution N~(6.7, 4) of the investors' opinions.**




The two functions PB and IR are plotted in the single space ($b^*$, $i$) in Figure 3, to which the value of $\bar{b}$ is added. As the baseline case, the IR equation is plotted for $h$ = 0. The geometry of these functions allows for multiple intersections or "equilibria" (at most two). Figure 3 represents the case of two equilibria: $G$ is a "good" equilibrium (low $b^*$ and $i$), $B$ is a "bad" equilibrium (high $b^*$ and $i$). Their economic meaning is that they denote points in which the value of $b^*$ determining $i$ via the IR function coincides with the value of $b^*$ determined by $i$ via the PB function. These points can therefore be understood as steady states of the debt market in the *interaction process* between $b^*$ and $i$ driven by the two functions.

**Figure 3. Interest rate and solvency primary balance**



Let us consider an initial arbitrary value of $i_0$ in Figure 3. On the PB line we can read the value of $b^*_0$ consistent with $i_0$. But the IR curve indicates that for $b^*_0$ the market demands a lower $i_1$, which allows for a lower $b^*_1$ and so on until the process converges to point $G$. The same happens if we start to the left of $G$, with $i$ and $b^*$ increasing up to $G$.

Now the reader can repeat the same exercise for an arbitrary initial value of $i$ to the right of point $B$. It is easily seen that the subsequent process deviates cumulatively from $B$ because at each step the market wants a higher $i$ which requires a higher $b^*$ and so on. This process will go on until the government's default trigger value $\bar{b}$ is hit.

Therefore, we have thus far established that

(P1) a) *If two equilibria exists, the good equilibrium is an attractor for any initial condition below the point of bad equilibrium.* b) *For any initial condition above the bad equilibrium, the process is bound to default.*

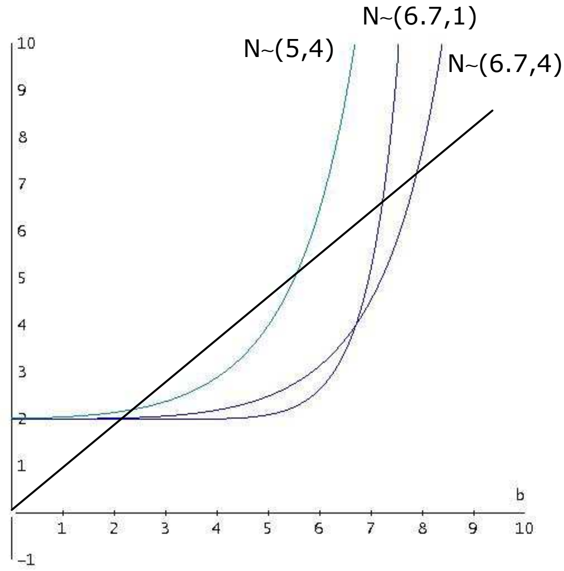
The analytical properties of the model encapsulated in proposition (P1) indicate that the bad equilibrium is unstable, so that the system actually has two domains of attraction, one towards the good equilibrium (on the left of $B$), the other towards the default event (on the right of $B$). We shall now explore some other properties of the model in relation to some vexed issues raised by the recent crisis of sovereign debts.

### 3.4. Initial conditions

The first interesting issue is how good the fiscal outlook should be in order to remain within the good-equilibrium domain. As can be seen from Figure 3, the extent of this domain is determined by the location of the two equilibrium points. Clearly, given the IR curve, harder fiscal conditions, represented by a flatter PB line, reduce the good-equilibrium domain. On the other hand, for a given state of PB, this domain may shrink owing to the position and curvature of the IR curve. This, in turn, depends on the frequency distribution of investors' opinions.

It is interesting to note that the IR curve reduces the good-equilibrium domain (i) the lower is the market opinion $\bar{b}_M$ with respect to the true $\bar{b}$ or (ii) the more the frequency distribution is concentrated around the central value ("opinions coagulate"). The first case is a violation of the cross-sectional rational expectations hypothesis, but it may nonetheless be of some relevance, for opinions may prevail over the reality as the government, *coeteris paribus*, finds itself in the attraction domain of default in spite of the fact that its true $\bar{b}$ is higher than expected by the market. The second case amounts to the reverse of what is commonly called a "mean preserving spread" of the distribution. As an example, Figure 4 shows the IR curves generated by continuous Normal distributions that differ in their means and variances.

**Figure 4. The IR function with different Normal distributions of investors' opinions.**




Take N~(6.7, 4) as benchmark. A lower variance makes the IR curve steeper, whereas a lower mean makes it shift leftwards. In both cases, for a given PB line, the bad equilibrium point shifts downwards, and the attraction domain of the good equilibrium shrinks.

This feature casts a problematic light on factors that may foster opinion reshufflings or coagulation, such as the role of opinion leaders or opinion makers (official institutions, rating agencies, *gurus*, etc). Even though opinions coagulate around the true $\bar{b}$ (which cannot be taken for granted), the consequence is that the initial conditions are less favourable to debt stabilization[9].

In sum, good fundamentals (e.g. low $b^*$) make it more likely that the market settles down in the good equilibrium. On the other hand, the government may find itself on the path bound to default owing to unfavourable initial conditions. The point is that *all* equilibria, good and

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9 This fact relates to the more general principle that heterogeneous information induces to trade, which makes the market more thick and prices less volatile, whereas homogenous information has the opposite effects.

bad, *depend on fundamentals as well as investors' opinions in a way that cannot be disentangled*[10].

**3.5. Shocks**

The present model can deal with two types of fiscal shocks. The first type changes the slope of the PB line, the second shifts the line. The first type is due to changes in the nominal growth $n_{t+1}$, the second is due to additional factors that change the value of $b^*_{t+1}$ *coeteris paribus*. The latter may consist of monetization $m_{t+1}$ or other extraordinary operations $s_{t+1}$ that affect the solvency condition. These shocks should be understood as news at time $t$ about the relevant variables at $t$+1 (in fact, most fiscal measures take time to be implemented). A particular shock that is worth mentioning occurs when the government misses the target $b^*$. Actually, this is an *ex-post* shock, but it can easily be accommodated within the model. If at any point in time $t$ $b_t < b^*_t$, the consequence is that the outstanding debt stock $d_t$ rises, the PB line becomes flatter so that the new solvency condition requires a higher $b^*_{t+1}$.

The model can also deal with market shocks, that is, changes in the IR curve. The most relevant cases relate to the properties of the curve discussed above, namely a change in the market opinion $\bar{b}_M$ or a mean preserving spread (shrink) of the frequency distribution of investors' opinions. The IR curve also depends on the risk-free benchmark interest rate $\bar{i}$, and the haircut $h$. Fiscal and market shocks can, of course, compound.

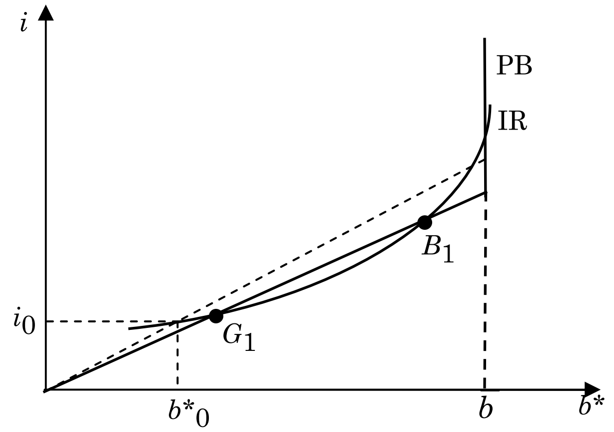
Starting at the good equilibrium point, the outcome of any type of shock eventually depends on the new configuration of the two functions. Focussing on negative shocks (a flatter or lower PB line, a higher or steeper IR curve), the key issue is whether or not a new set of equilibrium points exists. If it exists, then the system will converge to the new good equilibrium; otherwise it will diverge up to default.

To exemplify, let us examine the two cases portrayed in Figure 5 (again the time subscript is suppressed) Case a) exemplifies a "small" negative fiscal shock due to bad news about lower $n$. To comply with the solvency condition, the government should plan a greater fiscal effort against which the market sets a higher interest rate. The process goes on until the new equilibrium $G_1$ is reached. Note that both $b^*$ and $i$ are eventually higher than they would be in the absence of an increase in the market default

[10] From this point of view, the present model differs from those of the Calvo type (1988), where a distinction is drawn between fundamental and non-fundamental equilibria.

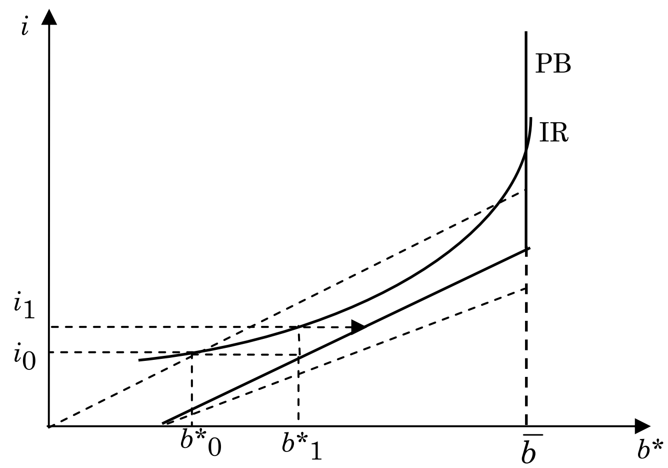
probability (the movement along the IR curve). However, in the region of low $b^*$ and flat IR this effect may be small or negligible.

**Figure 5a. Shocks**




Case b) exemplifies a "large" negative fiscal shock $s > 0$, e.g. a bailout of banks as in Ireland or Spain, that shifts the PB line below the IR curve so that no new equilibria exist. The government plans the commensurate increase in the primary surplus $b^*_1$, while the market attaches a higher probability of default to it that raises the interest rate to $i_1$ where the government should implement an additional primary surplus, and so on up to the actual default decision of the government. This is a typical case of a self-fulfilling, non-fundamental attack depending on initial conditions, because $b^*_1$ is sustainable by the government, and from that point onwards nothing changes in fundamentals that justifies the attack. The dotted PB line rotated downwards exemplifies the presence of Keynesian effects of the greater primary balance $b^*_1$. The reader can easily verify that, along the dotted line, the self-fulfilling process is amplified.

**Figure 5b. Shocks**



### 3.6. Inexplicable patterns in risk premia?

Having established the basic properties of the model we can now examine some issues that are currently under discussion, especially in connection with the euro-sovereign crisis.

Let us go back to the plots of the IR function. Note that in the low tail of values of $b^*$, the interest rate appears insensitive. This is a noteworthy feature that can shed some light on one of the several puzzles that have recently emerged in the standard theory of risk premia. Why did spreads across euro-sovereign debts remain so small until 2009 regardless of differences in debt stocks and deficits? Why do the United States or the United Kingdom or Japan pay negligible spreads in comparison with not so fiscally worse (or even better) euro-sovereigns?[11]

This model suggests that debt stocks and deficits do not matter *per se* but in relation to their distance from the good equilibrium and the market opinion $\bar{b}_M$. The fast and persistent convergence to low interest rates of countries joining the EMU may have been the consequence of sudden favourable changes in investors' opinions in the directions opposite to those exemplified in Figure 4. As a consequence, the good-equilibrium domain became larger, while a longer flat tail of the IR curve made interest rates appear almost insensitive to country levels of $b^*$. Likewise, the friendly treatment of US, UK or Japan's bonds may be due to the fact that their foreseeable fiscal efforts, albeit large, are *for the time being* safely away from the expected default threshold of their respective governments so that they dwell along the flat tail of the IR curve. However, given the mutable nature of investors' opinions, sudden and large changes in the IR function may also explain dramatic changes in the pattern of risk premia.

### 3.7. Fundamentals *vs.* non-fundamentals

As a matter of fact, the explosion of spreads across euro-sovereign debts has raised the question as to whether or not they are supported by fundamentals. This is especially the case of Italy and Spain, and to some extent Ireland. Spain and Ireland were caught by the debt crisis on paths of high growth, low inflation and sound public finances. Italy was more fragile, but since 2011 it has brought current deficits under control and is developing substantial primary surpluses. According to a recent study by the Bank of Italy (Di Cesare et al. (2012)), about half of the Italian spread is non-fundamental. Some independent studies have identified components of spreads that are unrelated to country-specific variables (e.g. Manganelli and

[11] See De Grauwe and Ji (2012a) for evidence about these phenomena.

Wolswijk (2009), Sgherri and Zoli (2009), Attinasi et al. (2009), Caceres et al. (2010), Favero and Missale (2011), De Grauwe and Ji (2012a)).

The distinction between fundamentals and non-fundamentals also relates to the phenomenon of "contagion". After the global financial crisis, contagion has become popular in the financial literature as well as in the press. It is, however, a slippery concept. In highly integrated markets, it is physiological that financial variables in one country affect those in others, or that they display high correlation due to common shocks. Strictly speaking, contagion is a phenomenon that should be related to non-fundamental factors. Yet whether or not a shock in one country is to be excluded from the fundamentals of another involves some degree of arbitrariness or is at least open to discussion. For these reasons, identification of contagion is quite hard empirically. Nonetheless, active research since the crisis has offered an extensive set of results; most of the above-mentioned studies on spreads across euro-sovereign bonds also identify contagion phenomena. Albeit stylized, the present framework may help shed some light on these issues.

The fundamentals are captured by the PB function: the initial debt stock, the nominal growth rate, the interest rate. Market assessment is captured by the IR function and the underlying distribution of opinions about the default threshold. Note that the IR function also includes the haircut $h$, which may also be a matter of investors' conjectures, in particular the form of haircut due to currency devaluation. Hence, for instance, if news that Germany's growth will slow down feed the anticipation of a fall of growth in Italy, so that the latter's PB line becomes flatter (see Figure 5a), this cannot be classified as contagion. However, if news that Greece is closer to default feed the same opinion as to Italy and shift its IR curve leftwards (see Figure 4), this can be classified as contagion.

It should also be considered that, from the point of view of investors, default probability *is* a fundamental variable. Hence, complaints about non-fundamental spreads should mean that the default probability is miscalculated. But this is a difficult judgment to prove because what matters is the collective response of the market, not of single individuals. Here the stress is on the self-fulfilling nature of increasing fears of default *due to market collective behaviour* rather than to individual miscalculations[12].

### 3.8. Foreign debt *vs.* domestic debt

How the composition of debt affects investors' appetite is matter of extensive research, but the issue has recently been raised in the context of

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[12] The self-fulfilling prophecies hypothesis is directly tested by De Grauwe and Ji (2012b)

the crisis of the euro sovereign debt, pointing out a relationship among persistent current account deficits, accumulation of foreign debt and higher risk premia (Gros (2011), Gros and Alcidi (2011), De Grauwe (2011)). This relationship is, however, controversial (Obstfeld (2012)). My aim here is not to take a position but to show how the discussion can be clarified within the present framework.

One controversial issue is why a larger share of foreign debt should come with a higher risk premium. In the present model, higher risk premium may be the result of either worse fundamentals or worse market opinions. As to fundamentals, there is no clear connection with the composition of debt; nor is there such a connection in the relevant literature. Hence the problem lies in the way the foreign component of debt affects market opinions, that is, the IR function.

The problem can be addressed from two different viewpoints: that of investors in general, and that of foreign investors in particular. As to investors in general, one argument is that the presence of foreign debt restricts the government's unlimited ability to service its debt because foreign investors cannot be taxed. Since the tax burden would fall on the sole shoulders of domestic taxpayers, the government's solvency costs, both economic and political, would be higher. As a consequence, the market opinion about the default trigger value $\bar{b}_M$ would be lower, which, as seen above, would determine a higher risk premium *coeteris paribus*.

As to foreign investors, an oft-heard argument is that they may fear the so-called "selective default". If the government could default on foreign debt only, the default costs would be reduced by their domestic component. This conjecture lowers $\bar{b}_M$ and concentrates the risk on foreigners at the one and same time. A complementary argument is that foreign capital is typically more volatile than domestic capital[13], so that firesales of the government bonds would be fast and large. However, selective default in a highly integrated financial system of cross-border private investors mixed up with large multinational entities is technically and legally quite problematic (e.g. private foreign investors may hold shares in resident investment funds holding domestic debt).

As already said, a particular specific risk faced by foreign investors is currency devaluation, which we may treat in the model as a haircut $h$. If $h >$ 0, the IR curve shifts upwards by the same amount weight?ed by the share of foreign debt, generating higher risk premium and a reduction of the attraction domain of the good equilibrium. To offset this devaluation risk, governments may issue debts in foreign currency. From this viewpoint, euro

13 Recall for instance the literature on the so-called "sudden stops" of capital inflows (Calvo and Reinhart (2000))

sovereign debts should offer total protection to other euro-resident investors (not to non-euro-resident investors). In fact, data suggest that until 2008 the devaluation risk premium almost disappeared from euro-countries' bonds (Wyplosz (2006)). By contrast, the ECB's concern with excessive spread for specific countries is mostly attributed to conjectures about their exit from the Eurosystem (Draghi (2012)).[14]

On the other hand, if denominating domestic debt in foreign currency may drive the devaluation risk premium towards zero, it also gives rise to the so-called "original sin" experienced by some emerging countries, in that it limits the government's ability to service its debt by way of monetization, so that its fiscal effort is higher *coeteris paribus* (Eichengreen et al. (2005)). Hence the benefit of offsetting $h$ from the IR function should be weighed against the damage of offsetting $m$ from the PB function. Some scholars argue that this balance has turned negative for EMU countries (De Grauwe (2011), Buiter (2012b), Gros (2012)), with the "original sin" also possibly feeding the conjectures that countries may eventually opt for exit, so that (some) EMU countries have both $m = 0$ and $h > 0$.

Overall, the present model suggests that a high share of foreign debt may act adversely, but the actual effect depends not so much on foreign debt *per se* as on its interaction with other economic and institutional factors that shape the market opinions.

## 4. How to escape from the attraction domain of default

This last section is devoted to discussion of some policy implications of the model presented above, with references to euro-sovereign debt crisis. I shall concentrate on the most critical policy problem, the one that arises when the government finds itself in the default attraction domain. A possible use of the model may be to avoid bad policy actions if not to prescribe the best ones. To begin with, an intrinsic feature of the model is that seeking to disentangle whether the situation is due to bad fundamentals or adverse market opinions is pointless.

### 4.1. Sustainability *vs.* credibility

The PB-IR model hinges on the investors' assessment of *sustainability*: that is, the chance that at any point in time the government is willing or able to sustain the level of fiscal effort $b^*_{t+1}$ required by the solvency condition. It is important to stress that this approach is in part analogous to, and in part different from, the celebrated one of *credibility*.

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[14] However, Favero and Missale (2001) find that this risk component in current spreads is not so large.

In the credibility approach, governments are urged to announce and implement large fiscal adjustments that are rewarded with *lower* interest rate (e.g. Corsetti et al. (2010)). By contrast, sustainability predicts that such governments will still pay a *higher* interest rate (as in the new equilibrium $G_1$ in Figure 5a). The two approaches give the same prediction in the case of a government that fails to achieve the target $b^*_{t+1}$: the interest rate will rise (see Figure 5a, which also applies to the case of the government that misses the target $b^*_0$ and then faces a higher debt and a flatter PB line).

The shift from a credibility to a sustainability approach by investors is probably playing a role in making the euro-sovereign debt crisis so difficult to manage. This shift of approach may have caught national and super-national policy makers brought up in the credibility doctrine by surprise. The latter, in the different context focused on sustainability, may in fact provide misleading policy prescriptions.

### 4.2. Why "austerity" may not work

The traditional "shock therapy" of front-loaded, "ambitious" fiscal consolidation plans, also known in Europe as "austerity", hinges on the credibility approach, and it has now become highly controversial well beyond the circles of traditional opponents[15]. Greece, Portugal and Ireland have been subjected to shock therapies as conditionality for access to rescue funds. The new governments of Italy and Spain in power since 2011 have sought to follow the same strategy pre-emptively. The punishment, or lack of reward, in terms of spreads of hard austerity plans *implemented* by countries like Italy and Spain, or the self-defeating effect of conditionality plans in Greece and Portugal (and partly in Ireland), raise the thorny issue of whether such plans were too small (non credible) or too large (non sustainable). Relevant data are presented and discussed in the Appendix.

The debate on austerity may convey the idea that the dividing line is whether or not austerity has negative effects on growth. This idea is misleading. Of course, such effects may matter greatly on any account. However, as recalled above, the credibility road to success is opened by the fall of the risk premium. Hence, even though austerity may have short-run negative effects on growth, these may be compensated by a permanent cut of the risk premium. On the other hand, we have seen that in the sustainability approach austerity may work adversely independently of negative effects on growth.

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[15] See among others the *Forum* organized by the website *Vox* (www.voxeu.org) and Corsetti (ed., 2012)

The point of the sustainability approach is that when a government is within the default domain, or close to it, announcing *and implementing* harder fiscal plans is not the right move because, as explained above, it will boost the risk premium even though the plans are initially sustainable. Consequently, EMU reforms that hinge exclusively on the hardening of the Maastricht doctrine of "rules + punishment", like the Fiscal Compact, are also disputable on the same grounds (e.g. De Grauwe (2011), Wyplosz (2011), Roubini (2012)).

**4.3. Can market opinions be tamed?**

If escaping the fatal attraction of default by struggling to improve the PB function by one's own means is very hard, and probably hopeless, can the rescue come from taming the IR function? The task is, of course, no less hard.

To begin with, the present model suggests mistakes that should be avoided but that have been made in the euro debt crisis. Three examples are these: tightening of monetary policy, "private sector involvement plans" (i.e. haircuts), conjectures of "easy exit". The first two examples raise $\bar{i}$ and $h$, respectively. The third, *de facto* or via market opinions, lowers the cost of default, and hence $\bar{b}$ and/or $\bar{b}_M$. At the same time, in the case of EMU, investors may also anticipate a higher $h$ via currency depreciation. In all cases, the IR curve shifts upwards and/or becomes steeper, and, *coeteris paribus*, the attraction domain of default widens. By contrast, loose monetary policy, capital loss protections, and high default and exit costs may help.

Any government may find it desirable to tell investors the truth about its $\bar{b}$, especially if the current fiscal effort is far from it. However, this may not be an easy task. A possibility, which I leave for further developments of the model, is that investors' opinions change endogenously as they learn from the government's behaviour. This possibility moves the sustainability approach closer to the credibility one. For a government able to fulfil larger solvency conditions may induce pessimistic investors to revise their opinion about $\bar{b}$ upwards, exerting a favourable modification on the IR curve. However, consider that the attraction domain of default is reduced, but not nullified, even if $\bar{b}_M = \bar{b}$, and that coagulation of opinions around $\bar{b}_M$ favours the government when its fiscal outlook is in the good-equilibrium domain, but it hurts sustainability when the government dwells close to or beyond the bad equilibrium (see Figure 2).

### 4.4. Pitfalls in the "country-by-country" approach

Another pillar of the Maastricht doctrine is questionable in light of the sustainability approach, namely the exclusive "country-by-country" approach with the well-known prescription that "everyone has to do their own homework". More than wrong, this prescription is inconsistent in a highly integrated system. "A monetary union creates collective problems" (De Grauwe (2011), p. 18). As discussed above, in such a system there exist both channels of structural interdependence and of non-fundamental contagion across countries, and *both* should be taken into account. The very principle of "rules + punishment" cannot stand if the current state of a country cannot be traced back to its own exclusive responsibility, and if the effects of its policy choices will depend on those of others too.

For instance, the effects of austerity on growth may be quite different depending on whether it is adopted in one single country or in the system as a whole (Tamborini (2011)). The consequent magnification of negative effects may transmit debt unsustainability across countries. An important contagion channel that we have seen at work in the euro-debt crisis, midway between fundamentals and non-fundamentals, goes through the banking system and its link with public finances. Initially, the risk of default by Greece was translated into expectations of large losses of foreign banks (especially German, Italian and French) and of public bailouts ($s > 0$) thus worsening the fiscal outlook of their home countries.

If each country should eventually be held responsible for its own policy choices, these cannot be gauged as if each country were an isolated entity. It is a basic principle of economic policy that if there are policy externalities, these should "internalized" either via voluntary cooperation or via an upper-level institution[16].

### 4.5. *Ex-ante* protections and *ex-post* rescue systems

A well constructed building has both efficient protections to prevent accidents and efficient rescue systems if an accident occurs. I have already pointed out above some design flaws in the Maastricht doctrine impinging upon the Stability and Growth Pact and subsequent reforms. *Ex-ante* protections were almost exclusively centered on country-by-country "rules + punishments"; *ex-post* rescue systems were almost non existent. This choice was made, and is currently defended, in order to avoid moral hazard in fiscal policy. This is a serious and noble aim, but it cannot be overstretched to the point of leaving the building without rescue systems. Overall there was a serious misconception of the variety of fiscal shocks and problems that

[16] See the classical Cooper (1986)

may arise and propagate in a monetary union beyond governments' profligacy.

It is certainly true that sound fiscal policy ranks high among *ex-ante* protections. The full half of the glass is that the good-equilibrium domain may be sufficiently large and comfortable. So it was (perhaps too much) in the pre-crisis years. However, reaching, and remaining in, the good equilibrium is largely, *but not exclusively*, a single country's "homework". Fiscally sound countries may be resilient to small idiosyncratic shocks around the good equilibrium (e.g. Figure 5a), but the hard lesson of the euro-debt crisis is that they may be overrun by large systemic shocks (e.g. Figure 5b). This eventuality was totally absent from the Maastricht view, and this is the front on which much more efficient *ex-ante* protection is most needed. Protection design should be consistent and comply with the high degree of economic and financial integration that lies at the very heart of the European construction. A typical example discussed above is given by the fiscal effects of large transnational financial shocks: transnational shocks require transnational protections, such as centralized financial surveillance, depositors' insurance and crisis resolution schemes and funds[17].

Insurance is of course a critical factor for efficient *ex-ante* protections. In a typical fiscal insurance scheme, each country, upon paying a commensurate premium *ex ante* can obtain fiscal transfers *ex post* in the event of exogenous fiscal shocks that push it towards the default domain. Insurance may have two favourable effects. *Ex ante* it lowers the cost of solvency, thus raising the default trigger point $\bar{b}$ ; this may also be anticipated by the investors, with the consequence that also $\bar{b}_M$ rises, the IR curve shifts rightwards, and the good-equilibrium domain widens (see Figure 2). *Ex post* fiscal transfers in fact reduce the fiscal effort necessary to restore solvency, thus shifting the PB line leftwards, possibly within the good-equilibrium domain (look at Figure 5b for reference). The usual moral-hazard counter-argument is that, anticipating a wider good-equilibrium domain, the government may be tempted to run looser fiscal policy *ex ante,* ending up with a fragile fiscal outlook – higher debt and a worse (flatter) PB line – when the shock hits. This temptation requires appropriate controls, which may include institutional safeguards like cross checking on fiscal policies[18].

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[17] These instruments go under the heading of "Banking Union" in the current EMU reform plans (Van Rompuy (2012))

[18] By and large these are the elements of the so-called "Fiscal Union" advocated in the EMU reform plans (Van Rompuy (2012)). Cooper (2012) discusses these issues within his formalized model.

In regard to *ex-post* rescue systems[19], I have already discussed why hardening fiscal austerity may not be the right policy within the default domain, and why changes in investors' opinions may not be easy to obtain. What is left are extraordinary measures that can shift the PB line leftwards within the good-equilibrium domain. These are basically monetization, $m > 0$, and direct operations on the debt stock, $s < 0$.

As already observed, historically these have been the most widely used solutions in episodes of large debt overhang. The PB-IR model highlights some aspects of debt monetization (by an independent institution) that usually go unnoticed in the fierce debate around this issue. Monetization is not an all-or-nothing option. By calibrating it, the central bank can obtain *both* debt stabilization *and* offer the government a support scheme that does not come as a free lunch and incentivates more virtuous policy.

Monetization can, in principle, shift the PB line leftwards by any amount decided by the central bank[20]. The minimal requirement for this policy to be effective is that the PB line is driven within the good-equilibrium domain. Indirectly, this implies a control, if not an explicit target, on the interest rate on sovereign debt. Consider again the shock scenario in Figure 5b. One option for the central bank is to restore the PB line in its *status quo ante* good equilibrium ($b^*_0$, $i_0$). But the central bank may wish to minimize monetization, shifting the PB line just "on" the IR curve, that is, at the tangency point. This is an interesting, albeit virtual, scenario. First, at the new equilibrium both $i$ and $b$ are higher than in the initial state: this may be interpreted as a penalty for monetization. Second, the tangency point is a single equilibrium for the system. If a new negative shock occurs, the government is again bound to default. If a positive shock, or fiscal consolidation, occurs, the government may settle down in a safer and better equilibrium: this may be interpreted as an incentive for the government to do its own part with fiscal consolidation[21].

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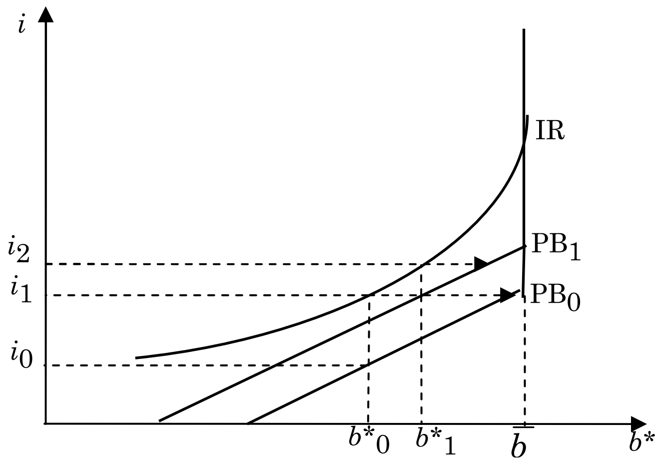
19 By *ex post*, I mean that they are not automatically activated as with insurance schemes. The analytical consequence is that they are not fully anticipated by investors. However, also these systems can become part of specific insurance schemes *ex ante*.

20 For the distinction between purchases in the primary or secondary market, see fn. 3)

21 Essentially the same policy results are obtained by Corsetti and Dedola (2011). They also show that, in the same conditions, forcing austerity does not foster reforms for fiscal consolidation. The basic ingredients mentioned in the text can be detected in the new "Outright Market Transactions" programme launched by the ECB whereby the central bank can buy in the secondary market short-term bonds of a country under debt attack against conditionality of fiscal adjustments signed with the European Stability Mechanism.

This finally brings us to the controversial issue of conditionality. Does conditionality prevent moral hazard and induce fiscal consolidation, or does it make default more likely? Let us consider again the $PB_0$ line in the bailout domain as in Figure 6. At the market rate $i_0$, the government is ready to stay solvent with fiscal effort $b^*_0$. However, at $b^*_0$ the market rate would rise to $i_1$, and the related primary balance would be unsustainable by the government. Then the government files for a rescue package, say some loan $s < 0$ with conditionality. This model clarifies that whether the conditionality is good or bad cannot be judged independently of the context. One critical factor is whether the loan is sufficient to reach the good-equilibrium domain. Suppose it is not, as shown in the figure. The loan $s$ shifts the PB line leftwards ($PB_1$). Given the market rate $i_1$, the conditionality commits the government to achieving the new solvency primary balance $b^*_1$. This is less than the non-sustainable $\bar{b}$ but greater than $b^*_0$.

**Figure 6. A model of the "Greek tragedy"**




Then we observe the following notable events. First, the rescue package *per se* has no effect on $i_1$. Second, as the government achieves $b^*_1$, the market responds with an increase in the interest rate to $i_2$, which again sets the government on an unsustainable path. Hence, it is the combination of conditionality with an insufficient loan that condemns the rescue package to failure. Note that we have obtained this outcome with no deflation effects of the conditionality on $n$, which would exacerbate the problem (the $PB_1$ line would tilt rightwards). This sequence of events is remarkably resemblant to what happened with the so-called "Greek tragedy".

The lesson of this model is that a successful rescue plan should be large enough to pull the government out of the default domain. This, of course, is by no means easy to engineer, not least because the IR curve is not easily detectable. A more drastic, but safer, approach is to recognize that the market response to the plan is not part of the solution but part of the problem. Therefore, the lending institutions should not seek to mimic the market, but entirely substitute the market by charging administered concessional interest rates with sustainable conditionality for all the time that is necessary to regain the good-equilibrium domain.

## 5. Conclusions

The ongoing dramatic euro-sovereign debt crisis has prompted a new generation of models of debt dynamics and management characterized by multiple equilibria (ME) due to interactions between fiscal fundamental variables and investors' assessment of default probability. Typically, these interactions may give rise to self-fulfilling attacks on the sovereign debt, leading to default in spite of initial sustainable conditions. In this paper I have presented a ME model in this vein, whose main novel feature is that default probability is not attributed to a single representative investor but is measured as the cumulated frequency of the investors' heterogeneous opinions regarding the sustainability of the solvency primary surplus to be achieved by the government. The model identifies an attraction domain of the government's default decision within which the government is bound to default although initial solvency conditions are sustainable. The extent of this domain may be larger or smaller depending on the interplay between fiscal fundamentals and the *distribution* of investors' opinions.

By means of this model I have addressed some controversial issues in the current debate on the euro-sovereign debt crisis, such as puzzles concerning the pattern of risk premia before and after the crisis, the identification of non-fundamental and contagion components in risk premia, the role of the foreign component of debt. Some relevant policy implications also ensue. First of all, it is crucial that *ex-ante* protection and *ex-post* rescue systems exist against the default attraction domain. In fact, it is hard for a government to escape from this domain by its own means. In particular, in this domain the so-called fiscal "austerity" is not the right response, even ignoring possible contractionary effects on nominal growth. For "ambitious" fiscal plans are assessed as unsustainable by a larger share of investors leading to higher, not lower, interest rate. Mutual insurance is prominent among *ex-ante* protections systems. I have shown how a typical insurance scheme, complemented with monitoring on fiscal fundamentals, can restrict the default domain. Among *ex-post* rescue systems, both central banks' interventions in the sovereign-debt market and bailout packages may be effective provided that they are large enough to remove the country's fiscal outlook from the default domain. Both instruments, implicitly or explicitly, entail the charging of a non-market interest rate as long as necessary.

Against this background, the EMU institutional framework based on the country-by-country "rules + sanctions" approach is ill suited to giving guidance in the current crisis. The "self-fulfilling prophecies" problem, and the role played by non-fundamental and contagion phenomena, are not contemplated, and the EMU provides neither *ex-ante* protection nor *ex-post* rescue. To date the EMU institutional setup has been part of the problem rather than of the solution. Notably, as also stressed by De Grauwe (2011), reforms suitable to addressing the problems analyzed in this paper are more modest and feasible than the grand design of the United States of Europe. Unfortunately, even on this lesser scale, obstacles remain more political than they are technical.

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## Appendix

In this Appendix I present some data that show the evolution of spreads of euro-sovereign debts *vis-à-vis* their fiscal effort. The data cover the three years 2010-2011-2012[22] in which almost all countries have engaged in fiscal consolidation. The data are organized in light of the PB-IR model, and hence for each member country $m$ and each year $t$ Table A1 gives the target primary balance $b^*_{mt}$, the realized primary balance $b_{mt}$, its difference over the previous year $\Delta b_{mt}$, the deviation from target ($b_{mt} - b^*_{mt}$) and the average monthly spread $s_{mt}$ of the long-term interest rate (ECB definition) over Germany. The choice of the target primary balance according to our PB function is somewhat arbitrary, because each country might have a specific target either self-imposed or imposed by external agencies. However, our definition of $b^*_{mt}$ represents the minimal requirement that keeps the debt/GDP ratio constant, whereas some countries under debt distress may have "more ambitious programmes" of debt reduction implying larger targets.

Identifying fiscal consolidation with a positive change in the primary surplus over the previous year, all countries except Austria, Germany and Ireland started fiscal consolidation in 2010. Then all countries carried on fiscal consolidation in the next two years except Austria-2012 and Luxembourg-2012. Figure A1 plots fiscal consolidation against spreads. The non-linear fit of the second order suggests that spreads in the EMU as a whole are poorly, and wrongly, related with fiscal consolidation: larger fiscal efforts have not been rewarded with smaller spreads.

According to the PB-IR model, investors asses actual primary balances against their target and sustainability. Indeed, except for Germany-2012, all countries have systematically failed to achieve their $b^*_{mt}$; as explained by the model, the consequence has been that the targets *increased* for all countries in 2011, and for Greece, Italy, Portugal and Spain also in 2012. Figure A2 displays fiscal consolidation against $b^*_{mt}$. Overall, larger fiscal efforts fail to correlate with stable or lower targets.

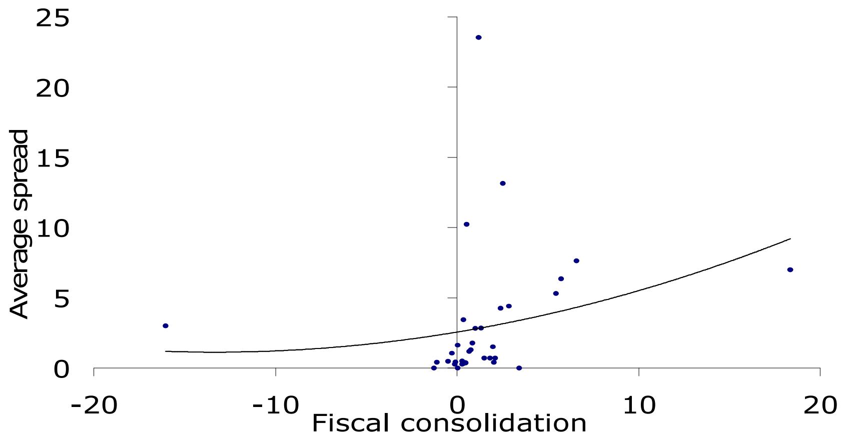
Combining the previous evidence, Figure A3 suggests a better explanatory variable for spreads, namely the deviations from target. In fact, the evolution of spreads seems to track such deviations rather closely. Finally, Figure A4 points out the time trajectories of the spreads and deviations from target of the countries under major debt distress (Greece, Ireland, Italy, Portugal and Spain). Recall that the theoretical relationship ought to be downward-sloping (arrows indicate the temporal trajectory). This has occurred systematically for Greece alone. Spain has been mistreated

[22] Eurostat official forecasts

systematically (with a rapidly increasing spread against less deviations from target), Ireland and Portugal in 2011, Italy in 2012.

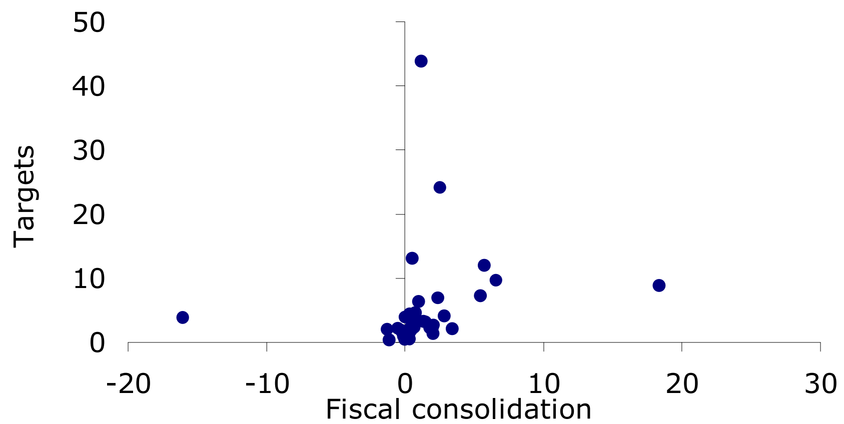
Overall, it may be argued that spreads have not rewarded fiscal adjustments mostly because the latter were too little. On the other hand, along with more formal tests such as those of De Grauwe and Ji (2012b), these data denote a scenario of "consolidation fatigue" which is not inconsistent with the sustainability view that the required adjustments were excessive. Setting ambitious fiscal targets is likely to produce deviations from target; the market does not look at the realized part of consolidation but at the missing part, and it responds with higher interest rates, which require even more ambitious targets and so on with the positive feedback mechanism described by the model.

**Figure A1. Fiscal consolidation (% of GDP) and spreads (%). EMU12 countries 2010-12**



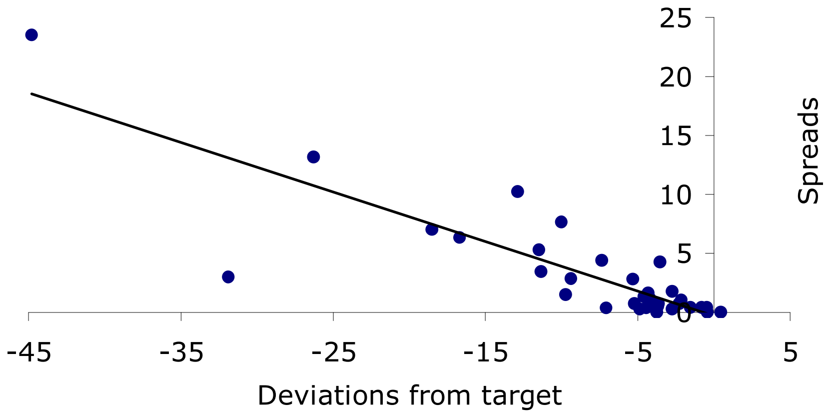

Source: Table A1

**Figure A2. Fiscal consolidation and fiscal targets (% of GDP). EMU12 countries 2010-12**



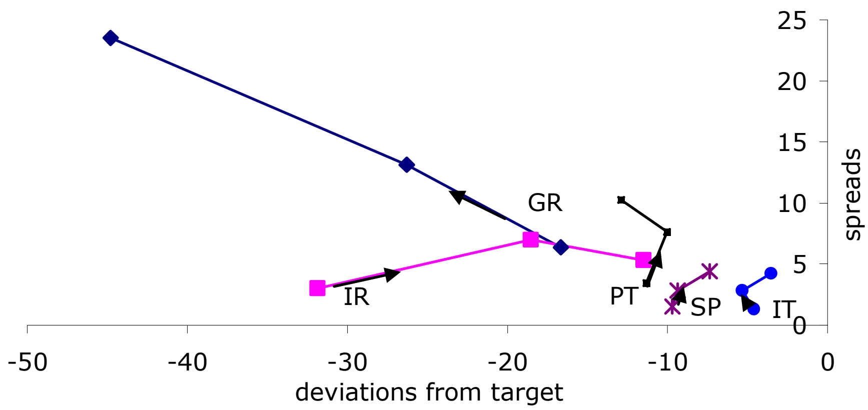

Source: Table A1

**Figure A3. Deviations from target (% of GDP) and average monthly spreads (%). EMU12 countries 2010-12**




Source: Table A1

**Figure A4. Deviations from target (% of GDP) and average monthly spreads (%). Greece, Ireland, Italy, Portugal, Spain, 2010, 11, 12**




Source: Table A1

**Table A1. Spreads and fiscal targets in the EMU, 2010-12**

| | | Austria | Belgium | Finland | France | Germany | Greece |
|---|---|---|---|---|---|---|---|
| 2010 | *d-1* | 69.5 | 95.8 | 43.5 | 79.2 | 74.4 | 129.4 |
| | *n* | 4.1 | 4.1 | 4.2 | 2.3 | 4.3 | -1.9 |
| | *i* | 3.2 | 3.5 | 3.0 | 3.1 | 2.7 | 9.1 |
| | *b** | 2.2 | 3.2 | 1.3 | 2.4 | 2.0 | 12.0 |
| | *b* | -1.8 | -0.4 | -1.5 | -4.7 | -1.8 | -4.7 |
| | $\Delta b$ | -0.5 | 1.5 | -0.1 | 0.5 | -1.3 | 5.7 |
| | *b-b** | -4.0 | -3.6 | -2.7 | -7.1 | -3.7 | -16.7 |
| | *s* | 0.48 | 0.72 | 0.27 | 0.38 | 0.00 | 6.35 |
| 2011 | *d-1* | 71.9 | 96.0 | 48.4 | 82.3 | 83.0 | 145.0 |
| | *n* | 5.3 | 4.1 | 6.6 | 3.3 | 3.8 | -5.4 |
| | *i* | 3.3 | 4.2 | 3.0 | 3.3 | 2.6 | 15.7 |
| | *b** | 2.3 | 3.9 | 1.4 | 2.6 | 2.1 | 24.1 |
| | *b* | 0.0 | -0.4 | 0.6 | -2.6 | 1.6 | -2.2 |
| | $\Delta b$ | 1.8 | 0.0 | 2.0 | 2.1 | 3.4 | 2.5 |
| | *b-b** | -2.3 | -4.3 | -0.8 | -5.2 | -0.4 | -26.3 |
| | *s* | 0.71 | 1.63 | 0.40 | 0.71 | 0.00 | 13.14 |
| 2012 | *d-1* | 72.2 | 98.0 | 48.6 | 85.8 | 81.2 | 165.3 |
| | *n* | 2.7 | 2.1 | 3.5 | 2.0 | 2.3 | -5.4 |
| | *i* | 2.6 | 3.3 | 2.0 | 2.7 | 1.5 | 25.1 |
| | *b** | 1.8 | 3.2 | 0.9 | 2.3 | 1.2 | 43.8 |
| | *b* | -0.3 | 0.4 | 0.5 | -1.9 | 1.7 | -1.0 |
| | $\Delta b$ | -0.3 | 0.9 | -0.1 | 0.7 | 0.0 | 1.2 |
| | *b-b** | -2.1 | -2.7 | -0.5 | -4.2 | 0.5 | -44.8 |
| | *s* | 1.06 | 1.78 | 0.43 | 1.19 | 0.00 | 23.53 |

| | | Ireland | Italy | Luxemb. | Netherl. | Portugal | Spain |
|---|---|---|---|---|---|---|---|
| 2010 | *d-1* | 65.1 | 116.0 | 14.8 | 60.8 | 83.1 | 53.9 |
| | *n* | -2.9 | 2.2 | 7.7 | 3.0 | 2.5 | 0.3 |
| | *i* | 5.7 | 4.0 | 3.1 | 3.0 | 5.4 | 4.3 |
| | *b** | 3.8 | 4.6 | 0.4 | 1.8 | 4.4 | 2.3 |
| | *b* | -28.0 | 0.0 | -0.4 | -3.1 | -7.0 | -7.4 |
| | $\Delta b$ | -16.0 | 0.8 | 0.0 | 0.3 | 0.4 | 2.0 |
| | *b-b** | -31.9 | -4.6 | -0.9 | -4.8 | -11.3 | -9.7 |
| | *s* | 3.00 | 1.29 | -0.13 | 0.27 | 3.43 | 1.51 |
| 2011 | *d-1* | 92.5 | 118.6 | 19.1 | 62.9 | 93.3 | 61.2 |
| | *n* | 0.3 | 1.7 | 6.3 | 2.3 | -1.0 | 2.1 |
| | *i* | 9.6 | 5.4 | 2.9 | 3.0 | 10.2 | 5.4 |
| | *b** | 8.9 | 6.3 | 0.5 | 1.8 | 9.6 | 3.3 |
| | *b* | -9.7 | 1.0 | -0.1 | -2.6 | -0.4 | -6.1 |
| | $\Delta b$ | 18.4 | 1.0 | 0.3 | 0.5 | 6.6 | 1.3 |
| | *b-b** | -18.5 | -5.3 | -0.6 | -4.5 | -10.0 | -9.4 |
| | *s* | 6.99 | 2.82 | 0.32 | 0.38 | 7.63 | 2.83 |
| 2012 | *d-1* | 108.2 | 120.1 | 18.2 | 65.2 | 107.8 | 68.5 |
| | *n* | 1.8 | 0.6 | 2.4 | 0.7 | -2.6 | -0.8 |
| | *i* | 6.8 | 5.8 | 2.0 | 2.0 | 11.8 | 5.9 |
| | *b** | 7.3 | 6.9 | 0.3 | 1.3 | 13.0 | 4.1 |
| | *b* | -4.2 | 3.4 | -1.2 | -2.3 | 0.1 | -3.3 |
| | $\Delta b$ | 5.5 | 2.4 | -1.1 | 0.3 | 0.5 | 2.9 |
| | *b-b** | -11.5 | -3.5 | -1.6 | -3.7 | -12.9 | -7.4 |
| | *s* | 5.30 | 4.25 | 0.41 | 0.51 | 10.23 | 4.40 |

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