Signalling Fiscal Austerity

Anna Gibert[†]

JOB MARKET PAPER

November 25, 2014

Abstract

Austerity measures may play the role of a signal about a sovereign's ability to repay its debt. A country may reduce debt below its optimal level in order to communicate its private information to the lenders. Since the opportunity cost of that reduction is lower for the more able sovereign, austerity is chosen to avoid imitation by the less able, thereby improving the price of debt. In a comparative statics exercise, a worse prior about the sovereign's ability makes the pooling price less attractive and may induce the high ability country to signal with austerity. Using a panel of 58 countries from 1980 to 2011, I proxy the deterioration in the market beliefs with the ratings capacity to add information that improves the perception about a country. Consistently with the model, I find an increased fiscal austerity associated with episodes in which the ratings are less informative.

JEL Classification: D82; F34; E62; G24.

Keywords: asymmetric information; sovereign risk; fiscal austerity; credit ratings.

[†]European University Institute. Via della Piazzuola 43, I-50133 Firenze, Italy. Email: anna.gibert@eui.eu.
I am grateful to my supervisors Piero Gottardi and Árpád Ábrahám for their continued support and advice. I am also indebted to Thomas F. Cooley for his invaluable help as well as Ana Fostel, Ramon Marimon, Juan José Dolado, Annette Vissing-Jørgensen, Christoph Trebesch, Tommaso Oliviero, Isaac Baley, Andrew Gimber, Vincent Maurin, Patricia Gomez and participants at the EUI working group, the NYU macro student lunch and conferences at UiO, Collegio Carlo Alberto, Lausanne University, ETH Zurich, Tor Vergata and the Bundesbank. All errors are my own.

1 Introduction

In the aftermath of the financial crisis 2007-08, there has been a surge in fiscal austerity in a number of European countries. For instance, in Spain, the government of Prime Minister Zapatero started a vigorous plan of 15 billion euros budget cuts in 2011, further extended to an additional 65 billion with the arrival of a new government led by Prime Minister Rajoy in 2012. In Italy, as well, drastic austerity packages amounting to 30 billion were implemented during the Monti administration (2011-2013). Fiscal consolidation reached the core of Europe too: in 2012, Germany announced plans to reduce the budget deficit by 80 billion until 2014 and in the UK the coalition government announced the biggest cuts in state spending since World War II.[1] At the supranational level, the Fiscal Stability Treaty entered into force on the 1st January 2013. Its title II establishes the Fiscal Compact, a series of rules regarding fiscal discipline that binds equally all the signatories. The Treaty has been ratified by 25 countries, consolidating the budget balance rule in their national law.

Some of the government leaders of the countries above have claimed that the reason behind austerity is to send a good sign to the markets about repayment prospects. Quoting the German Chancelor, Angela Merkel, *'austerity measures are adopted in order to send a very important signal'* to the markets[2] or the Spanish Prime Minister Rajoy, *'the priority will be to send a message to the markets [that] Spain is concerned about the issue of public deficit.'* In the UK, the Chancellor of the Exchequer, G. Osborne, sentenced: *'we have to convince the world that we can pay our way in the world.'*

However, the ability to repay may differ across countries that have a different ability to tax. A country that is more capable to raise taxes can mobilise resources easier in order to pay back debt. The citizens' attitude towards the measures that guarantee repayment varies from country to country. In some places they have been more readily accepted by the public than in others, where austerity has been rejected and fought back by the citizens. Hence,

[1] "EU austerity drive country by country", BBC News Europe, 21st May 2012. URL: http://www.bbc.com/news/10162176.

[2] "Merkelettes' Siren Song Sounds Very German", The Wall Street Journal Europe, 12th July 2011.

similar measures may be acceptable or not in different countries for idiosyncratic reasons and those are better known within the country than abroad.

In this paper I build a signalling model in which sovereigns with different ability to pay use fiscal policy strategically to reveal their private information. The fundamental trade-off of the model is the following: austerity is costly because the country has to deviate from its optimal inter-temporal allocation of consumption but it brings about a benefit in terms of the default premium the country pays in its debt price. For some parameters, the model predicts that countries pool together because austerity is too costly. However, when the perception about a country's ability worsens, the pooling price is less attractive and it may be convenient for the high-ability country to signal with austerity. I exploit this prediction of the model using several measures of credit ratings informativeness as a proxy for the market beliefs.

The sovereign ratings are long-run assessments about the probability that a country will honour its debt in full. Public perception about the ratings informativeness has experienced changes (Partnoy, 2006, Kiff et al., 2010, Bussiere and Ristiniemi, 2012, De Santis, 2012). The literature has hinted to several plausible reasons: conflicts of interest due to the change in the business model from investor-pay to issuer-pay model (Bar-Isaac and Shapiro, 2013, Holden et al., 2012, Manso, 2013, Mathis et al., 2009, White, 2010), increasingly more complicated products over time (Skreta and Veldkamp, 2009, Josepson and Shapiro, 2014) or the rigidities of the regulation (Opp et al., 2013, Cole and Cooley, 2014). I document these changes in informativeness and find evidence that higher fiscal austerity is associated with episodes in which it deteriorates, something that is consistent with the model. In addition, I present different robustness checks that control for other possible explanations of the surge of austerity, that are not accounted for in the model, and show that the result subsists.

Literature review. The conduct of fiscal policy has been traditionally envisioned as a way to distribute resources optimally across periods in order to maximise social welfare (Barro, 1979). But the fiscal policy has shown not to be countercyclical as predicted by the theory, thus promoting further research in order to explain this fact. On the one hand, political economists have theorised that the government might have a different objective function that the society, in particular, it is office motivated and short-sighted with respect to the citizens (Persson and Tabellini, 1999) and, on the other hand, there might be financial frictions constraining the countries to deviate from the first best policies, specially in emerging market economies (Cuadra et al., 2010). I claim that the existence of a problem of asymmetry of information can also be a compelling reason to deviate from the first best fiscal policy. Signalling models have proved useful to describe some stylised features of sovereign prices (Drudi and Prati, 2000), the decoupling of yields (Fostel et al., 2013) and the absence of more generalised defaults (Sandleris, 2008). The cited papers focus on the optimal policy, conditional on the type of country and other state variables and shocks, which unadvertedly releases information to the market as a result. My contribution is to study the mechanism by which a country manages strategically the release of information and, henceforth, the lender's beliefs. I focus on the signalling trade-off. In my model the sovereign truly internalizes the costs and also the benefits of its debt choice, through the effect it causes on its reputation at the lenders' eyes. I continue to provide empirical evidence of the signalling channel. Baldacci et al. (2013), Favero and Monacelli (2005), Gali and Perotti (2003) among others have estimated fiscal policy rules. I examine how the ratings informativeness affects the fiscal response. To the best of my knowledge this channel has not been explored before.

The paper is organised as follows. In the next section, I present the model and, in section 3, I characterise the equilibrium set. In section 4 I first analyse the effects of introducing a common budget balance rule and then of a sovereign credit rating. Section 5 is devoted to the empirical analysis. Section 6 concludes.

2 Model

Environment. Consider a model of sovereign debt in two periods between a sovereign borrower and foreign lenders, which are imperfectly informed about the type of the sovereign. The sovereign can be of two types, indexed by $i \in \{A, B\}$ with probability p and $1 - p$ respectively, depending on the ability to repay its debt. In the model, differences in the ability to repay come from differences in the ability to levy taxes on the citizens income. Country A might be more capable or more efficient to raise taxes than country B. Country A is, therefore, able to mobilise more resources of the economy in order to pay back the debt outstanding.

The model is based on the heterogenous ability to tax and the fact that such heterogeneity is not completely observable ex-ante. Taxation capacity depends on many factors, among others the country's income, the stock of debt and the government spending. My claim is that there exists at least another factor, that goes beyond the economic fundamentals, and that is inherently unobservable: the citizens' attitude towards the measures that allow debt repayment.

An example of this can be found in the aftermath of the European debt crisis in 2008-2010. A number of countries reacted to the turbulence in the market by implementing fiscal consolidation and other rationalisation measures. Something that was generally acclaimed as necessary by the international lenders. But these measures were not equally welcomed domestically: public wages cuts and a pension system reform, that passed in Spain, were rejected by the citizens in Portugal with massive protests and demonstrations, ultimately forcing the government to withdraw them.[3] This shows that similar measures may be politically acceptable or not in different countries and such idiosyncrasy is likely to be better known within the country than abroad.

Lender's problem. Foreign lenders are assumed to be risk-neutral.[4] They lend qD_t to

[3] "Portugal court rules public sector pay cut unconstitutional", BBC News Europe, 6th July 2012. URL: http://www.bbc.com/news/world-europe-18732184.

[4] Sovereign debt in the model is equivalent to external debt. The model could be extended to include

the sovereign, where q is the price of debt, and get repaid D_t in the next period if there is no default. Otherwise, default is complete: there is no partial repayment. Thus, the lenders profit function is:

$$\Pi = -qD_t + \beta' \left[\mu \left(1 - \lambda(D_t, 1)\right) + (1 - \mu)\left(1 - \lambda(D_t, 0)\right)\right] D_t, \tag{2.1}$$

where β' is the lenders discount factor. The term in brackets in (2.1) represents the expectation of debt repayment, which equals the probability that the country is of each type times the probability that each of these types repay. $\lambda(D_t, \mu)$ is the probability of default, that depends on the amount of debt and the common lenders' belief that the country is type A, μ. Perfect competition drives profits to zero and, as a result, the price is a function of the amount of debt and μ:

$$q(D_t, \mu) = \beta' \left[\mu \left(1 - \lambda(D_t, 1)\right) + (1 - \mu)\left(1 - \lambda(D_t, 0)\right)\right]. \tag{2.2}$$

Sovereign's problem. The problem solved by the sovereign is to maximise the citizens' utility with risk-neutral preferences, $c_1 + \beta\mathbb{E}[c_2]$, where β is the discount factor of the country. Citizens have an endowment in period 1, ω_1, and in period 2, ω_2, as their only income. ω_2 is drawn from an exponential distribution $f(\omega_2)$ with support $[\underline{\omega}, \infty)$ and hazard rate h.[5] The sovereign chooses the debt level D_t and taxes T_t on the citizens income in order to allocate consumption optimally across periods. There is no other role for the government: it does not provide public goods nor has to finance wasteful government spending. If the country

domestic debt but the effect of domestic debt on the citizens could be completely off-set by the presence of lump-sum transfers. Hence, the inclusion of domestic debt does not change the results.

[5]The exponential function is chosen for simplicity to be able to obtain closed form solutions, thanks to the constant hazard rate.

repays, a sovereign i is subject to the following constraints:

$$c_t \leq \omega_t - T_t \tag{2.3}$$

$$T_t \geq D_t - q(D_{t+1}, \mu)D_{t+1} \tag{2.4}$$

$$c_t \geq \underline{c}^i \quad t = 1, 2. \tag{2.5}$$

Constraint (2.3) is the budget constraint; it states that the citizens consumption is at most the endowment net of taxes. Constraint (2.4) represents the government budget. D_1 is given and common to both types and $D_3 = 0$ because debt cannot be rolled over in the last period. Finally, the ability to tax is capped by constraint (2.5), which guarantees a minimum $\underline{c}^i$ to the citizens that cannot be taxed away in order to repay the debt. Differences on $\underline{c}^i$ are the source of heterogeneity.

Assumption 1 *Assume*

$$\underline{c}^A < \underline{c}^B \tag{C1}$$

and

$$\underline{c}^B \leq \underline{\omega}. \tag{C2}$$

Default depends on the ability to pay. Accordingly, a country will not default if it can raise enough debt to satisfy its budget. Since $\omega_2 \in [\underline{\omega}, \infty)$, a sovereign has always a positive probability to repay any D_2. Therefore, it is able to get indebted in order to avoid default in period 1. As a consequence, default can only occur in period 2. A country defaults in period 2 if:

$$\omega_2 \leq D_2 + \underline{c}^i, \tag{2.6}$$

the current endowment of the economy is not enough to cover the external commitments and the domestic ones. This happens with probability $F(D_2 + \underline{c}^i)$, where $F(\cdot)$ is the endowment cumulative function. Given (C1), $F(D_2 + \underline{c}^A) \leq F(D_2 + \underline{c}^B)$ and type A defaults (weakly) less for any given debt level. In order to let the types be strictly different in their ability to repay at every debt level, I introduce the following assumption:

Assumption 2 *Assume:*

$$\underline{c}^B > \frac{\omega_1 - D_1 + \beta' \underline{\omega}}{1+\beta'}, \tag{C3}$$

which guarantees that type B is never risk-free.[6] Now, $F(D_2 + \underline{c}^A) < F(D_2 + \underline{c}^B)$.

In case of default, there is no need to raise taxes to pay the debt, $T_2 = 0$. The citizens consumption is assumed to be $\underline{c}^i$ and the remaining income ω_2 fully confiscated and destroyed. Nevertheless, due to assumption (C2), consumption $\underline{c}^i$ is budget feasible. Some kind of penalty is usual in models of sovereign default with finite periods in order to induce repayment. In this model, the choice of penalty implies that the condition for the country to be willing to repay, i.e. consumption after repayment to be higher than consumption after default,

$$\omega_2 - D_2 > \underline{c}^i, \tag{2.7}$$

is the same as the ability to pay in condition (2.6). This feature avoids dealing with inconvenient implications if a country is unwilling to repay but it is forced to. Further,

Assumption 3 *Assume*

$$\beta' > \beta \cdot e^{h(\underline{c}^B - \underline{c}^A)}, \tag{C4}$$

where $e^{h(\underline{c}^B - \underline{c}^A)} = \frac{F(D_2+\underline{c}^A)}{F(D_2+\underline{c}^B)}$ is the wedge between the default premia of the two types. The assumption says that, if the sovereign were price taker, debt is a ‘good’ because the discount factor abroad β' is higher compared to the domestic discount factor β (by a wedge that is high enough to compensate for the differential risk premium). External lenders are willing to finance a type B sovereign at a rate that is attractive domestically for both type A and

[6] The maximum level of debt that allows country B to be risk-free in the second period is $D_2 = \underline{\omega} - \underline{c}^B$. Assume that this level (or a lower one) would be unfeasible in the first period: $\underline{c}^B > \omega_1 - D_1 + \beta'(\underline{\omega} - \underline{c}^B)$, or reformulated, $\underline{c}^B \geq \frac{\omega_1 - D_1 + \beta' \underline{\omega}}{1+\beta'}$. Assumptions C3 and C2 are compatible as long as $\underline{\omega} \geq \omega_1 - D_1$.

B. This makes a sovereign *prefer to anticipate debt-financed consumption to re-payment.*[7] It remains to be determined how much of this cheap credit a country wants to use optimally, once it internalizes that issuing debt changes the relative price of debt versus repayment. And this affects different types differently.

Combining all the previous ingredients, the discounted expected utility of sovereign i is:

$$\begin{aligned} U^i(q, D_2; \omega_1 - D_1) := \omega_1 - D_1 + qD_2 + & \\ + \beta \left[F(D_2 + \underline{c}^i)\underline{c}^i + \left(1 - F(D_2 + \underline{c}^i)\right) \left[\mathbb{E}(\omega_2 | \omega_2 \geq D_2 + \underline{c}^i) - D_2 \right] \right]. & \end{aligned} \tag{2.8}$$

The first line of the right-hand-side is the citizens consumption in the first period: the endowment ω_1 minus/ plus the net lending/ borrowing of the period. The second line is the expectation of consumption in period 2 discounted by β: with probability $F(D_2 + \underline{c}^i)$, the country defaults and consumption is $\underline{c}^i$ and, with the complementary probability, consumption is the result of the endowment, noticing that ω_2 can only be a realisation compatible with repayment, minus the debt outstanding.

Expression (2.8) implicitly defines the indifference curves of the sovereign in the space of two key variables (q, D_2). Those indifference curves are represented in figure 1. The blue line depicts all the combinations of q and D_2 that give the same level of utility to type A and the red line to type B. Appendix B shows that, for all D_2, the slope of type B's indifference curves is larger than that of type A. This implies that any two indifference curves of A and B can cross at most once in the space (q, D_2). As a consequence, for a given change in debt, type B needs to be compensated more in terms of q than type A in order to remain indifferent. A decrease from D_2 to D_2', as depicted in figure 1, needs to be compensated with an increase from q to q_A' for type A and from q to q_B', a bigger compensation, for type B. The reason behind this *single-crossing* property of the preferences is that type B defaults in

[7] Other papers achieve the same results with different assumptions: for example, assuming the government needs to finance an investment project that pays in the future (Sandleris, 2008) or that office-motivated politicians like debt (Acharya and Rajan, 2011).

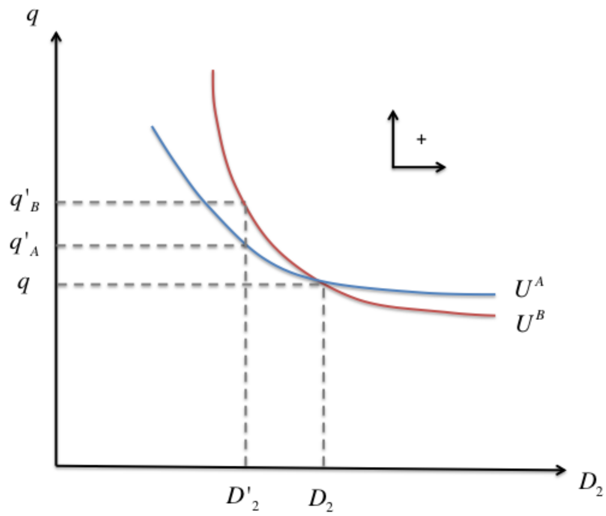


Figure 1: *Single crossing property*: the indifference curves of the two type cross at most once in the space (q, D_2).

more states than A and, when it does, its consumption is higher. Default is good news when a country cannot afford repayment and, as this depends only on ability to repay, B can do it more often.[8] Hence, it benefits more from debt because it has to pay back less.

3 Equilibrium analysis

3.1 Full information

As a benchmark, let us first find the equilibrium of the model when the type of sovereign is observable. The full information equilibrium allocation is a price and a debt level, q^i and $D_2^{FI}(i)\,\forall i \in \{A, B\}$, for each type. In this case, the lenders know type i's probability of default, conditional on the debt level, and charge an actuarially fair price $q^i(D_2) = \beta'\left[1 - F(D_2 + \underline{c}^i)\right]$. The sovereign internalizes this when it solves the maximization of the

[8]This result holds independently from the fact that the default penalty is higher for type A. Penalty could be make equal, provided it is not high enough to actually prevent default, and type B would still default in more states than A because default is not strategic.

discounted expected utility (2.8):

$$\max_{D_2} \quad \omega_1 - D_1 + q^i(D_2)D_2 + \beta\left[F(D_2+\underline{c}^i)\underline{c}^i + \left(1-F(D_2+\underline{c}^i)\right)\left[\mathbb{E}(\omega_2|\omega_2 \geq D_2+\underline{c}^i) - D_2\right]\right]. \tag{3.1}$$

Notice that the sovereign is not a price taker in (3.1). The term $q^i(D_2)$ recognises the effect of the choice of debt on the price. Thus, the FOC with respect to D_2 is:

$$\frac{\partial q^i(D_2)}{\partial D_2}D_2 + q^i(D_2) + \beta f(D_2+\underline{c}^i)\left[\underline{c}^i - (D_2+\underline{c}^i) + D_2\right] - \beta\left(1-F(D_2+\underline{c}^i)\right) = 0.$$

In the previous expression the terms in brackets cancel out because the change in default generated by the marginal unit of D_2 gives a utility post default of $\underline{c}^i + D_2$, the minimum consumption plus the foregone repayment, but a loss equal to the realisation of ω_2 right below the default point, that is exactly $D_2 + \underline{c}^i$. Three terms are left of the FOC:

$$\frac{\partial q^i(D_2)}{\partial D_2}D_2 + q^i(D_2) - \beta\left(1-F(D_2+\underline{c}^i)\right) = 0. \tag{3.2}$$

The first term represents the change in price that every infra marginal unit of debt experiences when an additional unit is issued. The second term is the gain from bringing consumption to the present at the current price $q^i(D_2)$. Finally, the third term is the cost of the repayment promise: a unit of debt needs to be paid in the future but only if the sovereign does not default, which happens with probability $1 - F(D_2 + \underline{c}^i)$.

Substituting the expression of the price schedule $q^i(D_2)$ in equation (3.2), after some transformations, we obtain:

$$D_2^{FI} = \frac{\beta' - \beta}{\beta'}\left[\frac{F'(D_2^{FI}+\underline{c}^i)}{1-F(D_2^{FI}+\underline{c}^i)}\right]^{-1}. \tag{3.3}$$

Proposition 3.1. *Denoting by h the hazard rate of the endowment exponential distribution $f(\cdot)$, the full information equilibrium debt for country type A is the same as for type B and* *equals* $D_2^{FI} = \frac{\beta' - \beta}{\beta' h}$.

Proof. Notice that the expression in brackets in (3.3) is the hazard rate of $F(\cdot)$. With constant hazard rate h, the right hand side of (3.3) is a constant and there is only one D_2 that satisfies the FOC. □

Condition (3.3) is a necessary condition for optimality and D_2^{FI} is the unique point that satisfies it. In the appendix A I show that D_2^{FI} is a local maximum. Uniqueness implies that it is also a global maximum. D_2^{FI} is equal for both types due to the functional form of $F(\cdot)$. But this allows us to obtain a unique closed form solution of the problem. Moreover, D_2^{FI} is positive because assumption (C4) makes $\beta' - \beta > 0$. It means that the country issues a positive amount of debt in order to take advantage of the favourable lending conditions. However, in equilibrium, in spite of issuing the same amount of debt different types face a different price, lower for type B because this type defaults more than the other:

$$\begin{aligned} q^B(D_2^{FI}) &= \beta' \left[1 - F\left(D_2 + \underline{c}^B\right)\right] \\ &< \beta' \left[1 - F\left(D_2 + \underline{c}^A\right)\right] = q^A(D_2^{FI}). \end{aligned}$$

3.2 Imperfect information

As a solution concept I adopt the Perfect Bayesian Equilibrium (PBE) in pure strategies. The country's strategy is a choice of debt D_2^*, that can be type dependent, and the lender's strategy is a debt price q^*, that depends on the observed D_2^* as well as the lender's beliefs about the type of sovereign.

Definition 3.1. *A symmetric PBE in pure strategies is a set of strategies for the sovereign and the lenders,*

$$D_2^* : \{A, B\} \to \mathbb{R}$$

$$q^* : \mathbb{R} \times [0,1] \to \mathbb{R}_+$$

and a common system of beliefs $\mu^* : \mathbb{R} \to [0,1]$ that assigns a probability μ^* to the country being of type A such that

- *A sovereign i chooses $D_2^*(i)$ that maximises its $U^i(D_2, q)$ given the lenders' strategy q^*.*
- *q^* let lenders break even in expectation given the system of beliefs $\mu^*(D_2)$ and the sovereign strategy $D_2^*(i)$.*
- *The system of beliefs $\mu^*(D_2)$ must be consistent with Bayes' rule and the equilibrium strategies whenever possible. That gives an equilibrium beliefs function:*

$$\forall D_2 \ \mu^*(D_2) = \frac{p\mathbb{1}_{\{D_2^*(A)=D_2\}}}{p\mathbb{1}_{\{D_2^*(A)=D_2\}} + (1-p)\mathbb{1}_{\{D_2^*(B)=D_2\}}} \text{ if the denominator is} \neq 0,$$

  where $\mathbb{1}$ is an indicator function that takes value 1 if the condition in parentheses holds and zero otherwise.

- *If the denominator is zero, beliefs must be consistent with probabilities derived from some distribution over the strategy profiles. This implies that $\forall D_2 \ \mu^*(D_2) \in [0,1]$ and $q^*(\cdot)$ is bounded between $\beta' \left[1 - F(\underline{c}^A + D_2)\right]$ and $\beta' \left[1 - F(\underline{c}^B + D_2)\right]$.*

Separating equilibria. An equilibrium is separating when a sovereign chooses a different debt level depending on its type. Let the equilibrium allocation be a vector of debt levels and prices denoted by $\{D_2^*(i), q^*(i)\}_{i\in\{A,B\}}$.

Recall that D_2^{FI} is the optimal debt for type B when the types are known. But, if types are not observable, B would like to pass off as type A because that would be beneficial in terms of the price of debt. In order to achieve that, it is willing to choose a different D_2. This is true up to the point where deviating is too costly, even if it guarantees to be granted a type A's debt price. This threshold level is the point where B's indifference curve passing through the full information allocation crosses the price debt schedule for $\mu = 1$, as shown in figure 2. Denote by D_2^{-B} the debt level that leaves B indifferent between deviating or not.

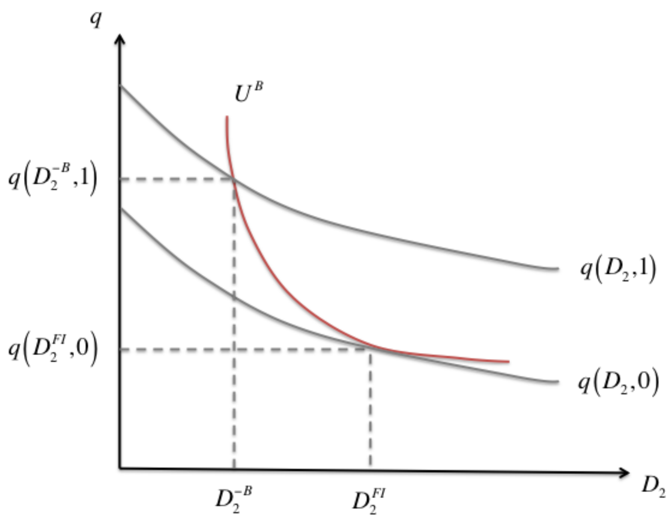


Figure 2: Sovereign B's indifference curves at the full information allocation.

Hence, we have that:

$$U^B\left(D_2^{-B}, q(D_2^{-B}, 1)\right) = U^B\left(D_2^{FI}, q(D_2^{FI}, 0)\right)$$

and, for $D_2 > D_2^{-B}$, the left-hand-side is strictly larger, thus, type B would like to choose it if it could pass off as A. On the contrary, for $D_2 < D_2^{-B}$, B would not want to imitate A no matter what the price consequences are. In any separating equilibrium type A will have to choose one of the debt levels $[0, D_2^{-B}]$ that discourages B from imitating and type B will consequently be happy not to deviate from its full information allocation.

Proposition 3.2. *There exists a separating equilibrium e^* at the allocation $(D_2^*(A), q^*(A)), (D_2^*(B), q^*(B))$, where $D^*(A) = D_2^{-B}$, $D^*(B) = D_2^{FI}$ and*

$$q^*(A) = \beta'\left[1 - F(D_2^*(A) + \underline{c}^A)\right] \tag{3.4}$$

$$q^*(B) = \beta'\left[1 - F(D_2^*(B) + \underline{c}^B)\right], \tag{3.5}$$

supported by the equilibrium beliefs $\mu^*(D_2^*(A)) = 1$ and $\mu^*(D_2) = 0$ for any other D_2.

Proof. Appendix C. □

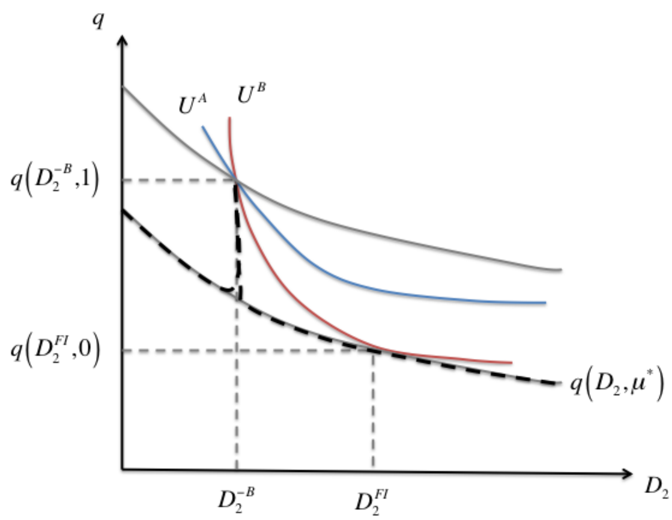


Figure 3: Separating equilibrium e^*.

The allocation $(D_2^{-B}, q(D_2^{-B}, 1))$, plotted in figure 3, is preferred by A to any other allocation under the system of beliefs represented by the dotted bold line. At the same time, B is indifferent by definition. This is because A's indifference curves are flatter than B's, hence, A is more willing to trade debt for price improvements and find allocations attractive that would not be so for B. Therefore, A chooses $(D_2^{-B}, q(D_2^{-B}, 1))$ while B remains at its full information allocation. But for A deviating from D_2^{FI} is costly as well. The further away D_2 is from D_2^{FI}, the higher the cost for A in order to signal. Since D_2^{-B} is the threshold debt level that allows separation of types, the equilibrium described in proposition 3.2 is the least cost separating equilibrium e^*. e^* involves a debt reduction by type A with respect to the full information equilibrium, $D_2^{-B} < D_2^{FI}$. This is what I refer to as 'signalling austerity'. Country A's deviation from its optimal allocation has to be interpreted as a self-inflicted cost in order to avoid being confounded with type B. This improves its debt price schedule, lowering the risk premium associated with each D_2. Recall (2.2) and take into account how $\mu(D_2)$ changes in equilibrium as a function of D_2:

$$q\left(D_2, \mu(D_2)\right) = \beta' \left[\mu 1 - \lambda(D_2, \mu(D_2))\right].$$

The signalling channel is an indirect effect that operates through $\mu(D_2)$. But being perceived as an A type entails choosing a lower debt level, as it has just been explained, thus it also has an additional effect on the risk premium coming directly from a lower D_2. Summing up, reducing the amount of debt to the D_2^{-B} level has a double effect: it directly improves the risk premium and it indirectly affects the perception of the type, which improves the risk premium further. If it were not for the indirect effect, though, type A would not choose to go through with austerity. Hence, the signalling channel is essential for the fiscal policy to tilt towards austerity.

Pooling equilibria. A pooling equilibrium exists when type A does not find it advantageous to reduce the amount of debt in order to obtain the benefits from revealing its type. Higher debt is preferred to a price improvement and type A accepts to be confounded with type B. As a result, the lenders cannot distinguish the types from their debt choices and their best guess is the prior p.

A pooling equilibrium consists of an equilibrium debt level D_2^* and a price of debt $q^*(D_2^*, p)$, equal for both types. For example:

Proposition 3.3. *A pooling equilibrium can be sustained at the full information allocation with $\mu^*(D_2^{FI}) = p$ and $\mu^*(D_2) = 0$ for any other D_2. The price of debt is equal to*

$$q^*(D_2^{FI}, p) = \beta' \left(p \left[1 - F(D_2^{FI} + \underline{c}^A)\right] + (1-p)\left[1 - F(D_2^{FI} + \underline{c}^B)\right]\right). \tag{3.6}$$

Proof. Appendix D. □

See figure 4, where beliefs are again represented by the dotted bold line. The off-equilibrium thread that a country will be penalised in their risk premium if it deviates from D_2^* might allow to sustain a pooling at a candidate D_2^*. As a consequence, any type of sovereign prefers to choose D_2^* and be offered the pooling price. Beliefs are admissible because in equilibrium the pooling price satisfies Bayes rule and off-equilibrium the beliefs, $\mu = 0$ in this case, are free to be any $\mu \in [0, 1]$. As it happened with the separating equilibria, a different system of beliefs may support other pooling equilibria.

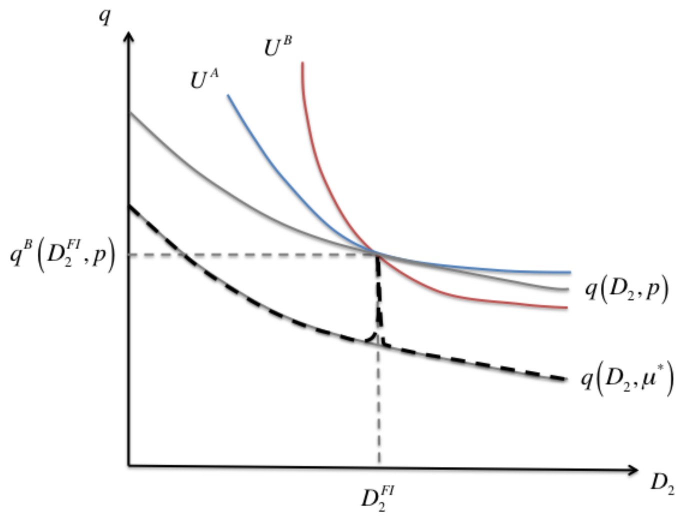


Figure 4: An example of pooling equilibrium.

3.3 Equilibrium refinement

A signalling model typically admits a multiplicity of equilibria. This is so because a large set of beliefs can be invoked, making it easier to sustain a given equilibrium by selecting the beliefs that give the candidate equilibrium the best chance. To reduce the set of equilibria I use the undefeated equilibrium (UE) refinement introduced by Mailath et al. (1993).

Unlike dominance-based refinements,[9] the UE refinement concentrates on the efficiency properties of the equilibrium. It regards any off-equilibrium strategy as an attempt of some (or all) types to coordinate to another equilibrium. Thus it restricts the off-equilibrium beliefs to be consistent with those of the equilibrium where such strategy would be played, if those types are (weakly) better off. The lenders, when they see a D_2 that is not part of the equilibrium, are only allowed to believe that the country is of the type(s) that would choose this D_2 in another equilibrium and would be better off doing that. If this consistency

[9]Notably by the intuitive criterion by Cho and Kreps (1987) and divinity by Banks and Sobel (1987).

requirement restricts off-equilibrium beliefs in such a way that they do not sustain the current equilibrium, this equilibrium is *defeated* and does not survive the refinement.[10] An equilibrium is said to be *undefeated* if it is not defeated by any other. Notice that the refinement introduces the requirement that the types choosing the off-equilibrium strategy be weakly better off in the new equilibrium. In the case of the pooling, since types choose the same D_2, both have to be weakly better off in order to defeat another equilibrium. Thus, the UE privileges the equilibria that are efficient in a Pareto sense.

Proposition 3.4. *Applying the UE refinement, separating and pooling equilibria do not coexist.*

The equilibria that survive the UE refinement are either a unique separating equilibrium or a multiplicity of pooling equilibria. First, notice that the least costly separating equilibrium e^* defeats any other separating equilibria. All separating equilibria reveal the type of sovereign but e^* does it with the smallest deviation from the full information allocation for type A. Hence, type A is strictly better off at e^*. This means that off-equilibrium beliefs at D_2^{-B} must be $\mu = 1$ for any other separating equilibrium but those beliefs do not sustain an equilibrium $D_2 \neq D_2^{-B}$ because such equilibrium would be defeated by e^*.

Furthermore, e^* defeats any pooling if type A is better off signalling. When choosing D_2^{-B} gives type A a higher utility, this cannot be ignored off equilibrium in any pooling and thus it is not consistent that A does not believe it will be better off deviating to D_2^{-B}. The pooling is therefore defeated. A formal proof can be found in appendix G. In this case, e^* is the unique equilibrium of the model.

But with the UE refinement e^* can also be defeated by a pooling e' if both types are better off at e'.[11] The proof is in appendix H. e' is undefeated if there is no other pooling in

[10]See appendix E for a formal definition of the UE refinement.

[11]Notice that with the 'intuitive criterion' (Cho and Kreps, 1987) the separating equilibrium can never be eliminated by a pooling. On the contrary, the separating always eliminates all pooling and it remains the unique equilibrium in this kind of signalling games of two players with single crossing preferences. The intuitive criterion says that if a deviation from a candidate equilibrium is dominated for one type but not for another, this deviation should not be attributed to the type for which the deviation is dominated. Hence,

which types are both better off. Hence, any allocation in the range $[D_2^{*A}, D_2^{*B}]$,[12] where D_2^{*A} is the allocation preferred by type A under schedule $q(\cdot, p)$ and D_2^{*B} is the one preferred by type B,[13] can be undefeated. If this is the case, the equilibria are of the pooling kind.

4 The role of the credit rating agencies

In this model the sovereign uses the fiscal policy to signal. The question might arise whether this result would still subsist in the presence of an alternative mechanism to signal. Well-known public signals about a country's creditworthiness are the sovereign credit ratings. They provide a public qualification of the country's debt at no cost. I examine if the addition of credit ratings to the model still leaves room for the emergence of 'signalling austerity'.

I introduce a credit rating agency (CRA) that is a public signal with imperfect information. The CRA has the ability to identify a type B country with probability ρ and assign a rating $\underline{r}$ to it: $\text{Prob}(\underline{r} \mid B) = \rho$. Otherwise the rating is $\bar{r}$. Thus, ρ represents the CRA's informativeness.[14] This simplifying assumption models the CRA as a wake-up call or an alarm sign. A rating $\bar{r}$ can be interpreted as *business as usual* since the CRA has no information on the contrary and a rating $\underline{r}$ means that the CRA knows that a country is less able to

no pooling equilibrium can dominate the separating e^* because the single crossing property creates a space between the indifference curves such that any D_2 to the left of the pooling allocation would be preferred only for type A and not for B. At every such D_2 beliefs must be such that $\mu = 1$ and those off-equilibrium beliefs cannot sustain the candidate pooling. The intuitive criterion fixes an equilibrium (e.g. e') and then restricts the off-equilibrium beliefs that are inconsistent with the dominated choices for each agent based on that equilibrium e'. Similarly, the UE fixes an equilibrium e' but the off-equilibrium beliefs at D_2 are restricted looking at another equilibrium where this allocation D_2 is an equilibrium allocation. Restrictions are established based on consistency with the type(s) that would choose D_2 in the new equilibrium, only if the type(s) are better off than at the fixed equilibrium e'. So the allocations that dominate the pooling allocation in the intuitive criterion do not exist in the UE because they are not equilibrium strategies of an alternative equilibrium. As a consequence, pooling can survive.

[12] Pooling equilibria in allocations outside that range are defeated by other pooling equilibria within that range because they are strictly preferred by both types. Within this range moving closer to one type's preferred allocation means moving further from the other; hence, types cannot be both made better off.

[13] In the appendix F I derive the expressions for D_2^{*A} and D_2^{*B}.

[14] ρ can take on different values $\in (0, 1)$ due to a number of reasons that are not explicitly modelled here: for example, a conflict of interest due to the issuer-pays model of payment would be represented as a decrease in ρ, as we go from investors-pay to issuer-pays model. Similarly, the difficulties to rate an increasingly complex set of products or the lack of attention to follow sovereigns that do not pay for their ratings would also imply a decrease in the parameter ρ.

repay. I restrict the analysis to one type of error - $\bar{r}$ when $i = B$ - and concentrate on the informativeness in the $\bar{r}$ category.[15]

Technically, the CRA in this model modifies the common prior p. The posterior is:

$$\hat{p}(\rho) = \begin{cases} \rho + (1-\rho)p & \text{if} \quad \bar{r} \\ 0 & \text{if} \quad \underline{\mathrm{r}}. \end{cases} \tag{4.1}$$

If $\rho = 1$ the CRA provides perfect information about the type of country and the solution is the full information one. If, instead, $\rho = 0$ we are in the baseline model with asymmetry of information. Therefore, the CRA can only ameliorate the *ex-ante* information problem of the lenders.

The market of debt becomes segmented into different markets conditional on the rating $\{\underline{\mathrm{r}}, \bar{r}\}$. In the rating category $\bar{r}$, the pooling equilibrium price of debt is:

$$q^*(D_2^*, \hat{p}) = \beta' \left[(\rho + (1-\rho)p) \left(1 - F(D_2^* + \underline{c}^A)\right) + (1 - \rho - (1-\rho)p) \left(1 - F(D_2^* + \underline{c}^B)\right) \right],$$

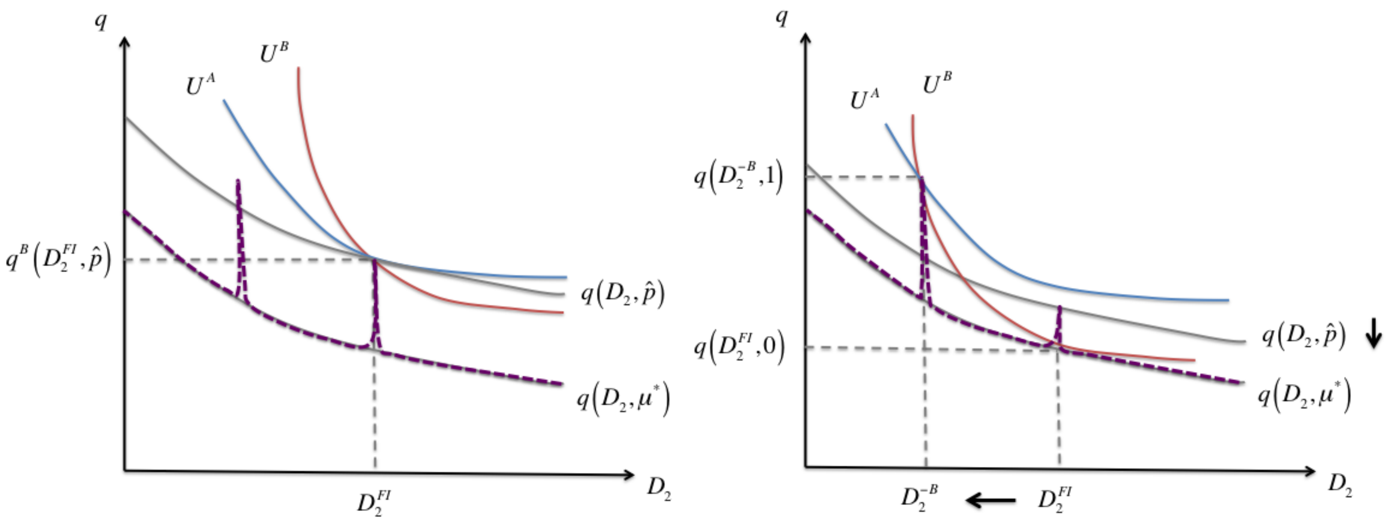
where the perception about a country depends on the prior and the ratings capacity to improve this prior with new information.

For a value of $p < \bar{p}$, the unique equilibrium of the problem without the CRA is e^*. $\bar{p}$ is the threshold level of the prior that makes type A indifferent between the signalling allocation $\left(D_2^{-B}, q(D_2^{-B}, 1)\right)$ and pooling with type B at $(D_2^*, \bar{p})$.[16]

Proposition 4.1. *If the prior $p < \bar{p}$, there exists a level of informativeness ρ^* of the rating $\bar{r}$ such that for $\rho \geq \rho^*$ the equilibrium is a pooling and for $\rho < \rho^*$ the equilibrium is e^*.*

[15] This could be extended to having two types of error - $\bar{r}$ when $i = B$ and also $\underline{\mathrm{r}}$ when $i = A$ - and the two categories would have imperfect information. The main prediction would not be affected as long as the rank order of creditworthiness in the rating categories is not reversed, i.e., as long as $\bar{r}$ contains more A types than $\underline{\mathrm{r}}$.

[16] The expression for $\bar{p}$ is $1 + \frac{\bar{U}^A - \omega_1 + D_1 + (2\beta - \beta')\left(1 - F(D_2 + \underline{c}_A)\right) - \beta(1 + \underline{c}_A + D_2 + h^{-1})}{\beta' D_2 \left(F(D_2 + \underline{c}_B) - F(D_2 + \underline{c}_A)\right)}$, where $\bar{U}^A = U^A\left(D_2^{-B}, q(D_2^{-B}, 1)\right)$.



(a) Equilibrium with $\rho \geq \rho^*$.　　(b) Equilibrium with $\rho < \rho^*$.

Figure 5: Shift from a pooling (left panel) to a separating (right panel) equilibrium.

Proof. Since the equilibrium is e^* for p, it follows that

$$\begin{aligned} U^A\left(D_2^{-B}, q(D_2^{-B}, 1)\right) &> U^A\left(D_2^*(p), q(D_2^*(p), p)\right) \\ &= U^A\left(D_2^*(\hat{p}), q(D_2^*(\hat{p}), \hat{p})\right) \text{ if } \rho{=}0. \end{aligned}$$

The left-hand-side is independent of ρ while the right-hand-side is increasing in ρ because $\frac{\partial \tilde{p}}{\partial \rho}\mid_{\bar{r}} > 0$. And for $\rho = 1-\epsilon$, with ϵ very small, the right-hand-side tends to $U^A\left(D_2^{FI}, q^A(D_2^{FI})\right)$ and the inequality is reversed. Hence, there must exists a threshold ρ^* where the equilibrium shifts from a pooling for $\rho \geq \rho^*$ to e^* for $\rho < \rho^*$. □

Corollary 4.1. *A deterioration of rating $\bar{r}$ informativeness from $\rho \geq \rho^*$ to $\rho < \rho^*$ makes 'signalling austerity' appear.*

A worse prior about the sovereign's ability means that more type B countries are perceived to be in the $\bar{r}$ category and the pooling price is lower for every level of debt. Type A would have to pool at some point along this new schedule in figure 5. But, when $\rho < \rho^*$, none of these points is preferred by A to the separating allocation. A worse perception of the $\bar{r}$-rated country makes it less attractive for A to pool with the other type, because the pooling price is too low, and it compensates to do austerity in order to reveal the type.

5 Empirical analysis

5.1 Dataset and empirical strategy

In what follows I present empirical evidence in favour of the signalling channel. Recall the main result from the the previous section: a low informativeness of the ratings, below a certain threshold ρ^*, implies an increased fiscal austerity in order to signal. The objective of the empirical analysis is to use the variation of ratings informativeness in the data and relate it to changes in fiscal austerity. I expect to find a higher (lower) ratings informativeness to be associated with a lower (higher) austerity by the sovereign.

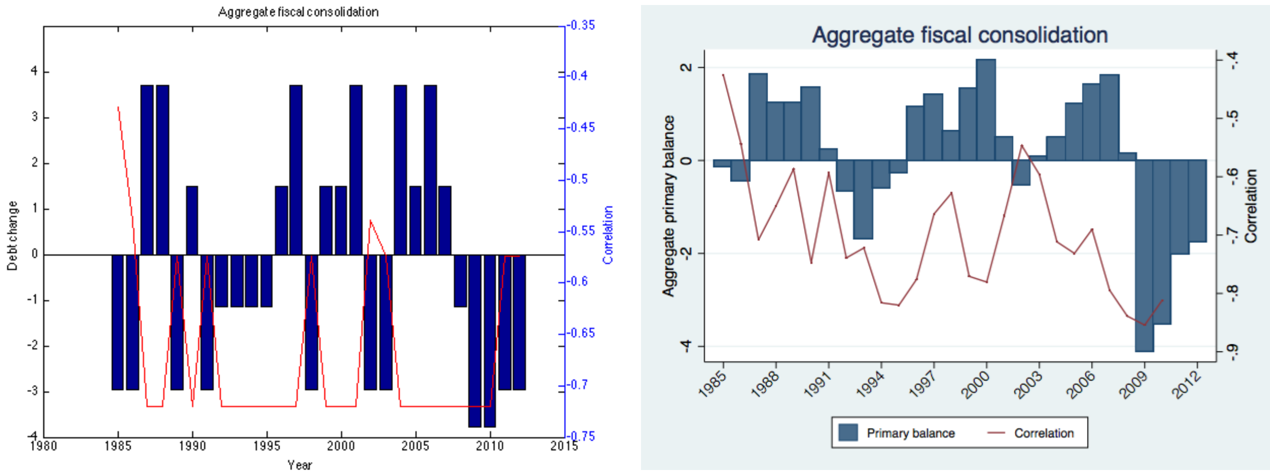
The two key variables of the analysis, informativeness and austerity, are difficult to define. I use the following variables to measure fiscal austerity: government net lending/ borrowing, primary budget, potential structural budget and government expenditure as a percentage of GDP. The convention is that positive values of these variables, except for expenditure, mean that the government is saving and negative values that it is borrowing. Hence, higher values represent more fiscal austerity. Government expenditure works the opposite way: lower values represent more austerity. The dataset contains observations of annual frequency for 58 countries during 32 years (1980-2011). Countries covered are mainly OCDE and some emerging market economies. For a complete list of countries and the range of years covered see the appendix I. The variables included in the dataset have been obtained from the World Economic Outlook (IMF) 2013 and their definitions and calculation method can be found in the appendix J. The dataset has been merged with the average yield to maturity in percentage points of long-term government bonds collected by the International Financial Statistics (IMF). In addition, an average annual rating is computed for each sovereign using the historical information on sovereign ratings obtained from the three biggest rating agencies: Moody's, Fitch and Standard & Poor's. The rating grades have been transformed into an ordinal variable with each rating and modulation of the rating (outlook/rating watch) represented by a unit change in a scale going from 0 (default) to 52 (AAA for S&P and Fitch or Aaa for Moody's). Ratings have been observed at the end of each month and an annual average constructed. The final *global rating* is obtained from the weighted sum of the ratings assigned by each agency to the country. Given that different countries started being rated by an agency at different points in time, [17] the panel is unbalanced. Still, there is no reason to believe that the initial observations for the non-rated countries are not randomly missing.

Informativeness below ρ^* translates into a low correlation between ratings and yields [18]. Sovereign ratings are a measure of the country's creditworthiness, that is, an evaluation of the sovereign's default probability. Comparing the default probability forecasted by the ratings and the true default probability is impeded because we rarely observe sovereign defaults. However, we do observe a different form of market evaluation of the country's creditworthiness, that is more volatile than ratings, in the sovereign yields. The market assesses the informativeness of the ratings over time and the correlation can be used as an indirect evaluation of the ratings informativeness by the market.

Simulating the model, I find the outcome of an economy that starts off every period. Figure 6a shows a possible path for the correlation and the aggregate austerity. Notice that a low correlation between sovereign yields and ratings is associated with a higher austerity. This is the pattern, compatible with the model presented above, that I find as well in the data.

Figure 6 plots the negative co-movement between the correlation variable and three measures of aggregate austerity. The three measures are: the primary balance of the government budget over GDP summed up for all countries (in green), the primary surpluses (in red) or deficits (in blue), with weights correcting for the number of countries in the sample each

[17] Moody's started rating sovereigns in June 1958, S&P in January 1975 and Fitch only in August 1994.
[18] Sovereign yields are calculated as the inverse of the price of debt



(a) Simulated data. (b) Actual data.

Figure 6: Negative co-movement between correlation and austerity.

year.

In order to test for this prediction I use the following econometric specification:

$$Y_{i,t} = \alpha + \beta Corr_t + \gamma X_{i,t-1} + \kappa_i + \epsilon_{i,t}, \tag{5.1}$$

where $Y_{i,t}$ is one of the several fiscal variables that proxy for austerity, $Corr_t$ is the Spearman rank correlation between the sovereign yields and the *global ratings* and $X_{i,t-1}$ are one period-lagged control variables. A negative β coefficient is suggestive evidence of signalling austerity. In the next section I adjust the specification to make the correlation more exogenous.

The empirical strategy until here has relied on the simultaneity of the shift between equilibria. In reality, it is possible that this change does not take place for all countries at the same time but it is sequential instead. If a country is being subject to more attention by the market at a certain point for any reason, for example it is about to issue new debt, its debt price might be seen by others as an anticipation of the markets assessment about its rating. In the logic of the model, we would expect to see other countries with the same rating interpret this as an indication of the equilibrium in place and choose their own austerity accordingly. I, therefore, calculate how many *large* price changes happen to a country in a given year and how this number affects the fiscal position one year ahead of the other countries in the same rating category. *Large* price changes should mean that the market anticipates a separating equilibrium, since the price distribution is more disperse. The regression I estimate is the following:

$$Y_{j,k,t} = \alpha + \beta \text{Price Shocks}_{i,k,t-1} + \gamma X_{j,t-1} + \kappa_j + \delta_t + u_{j,t}, \quad (5.2)$$

$\forall j \neq i$ in the same k. β here captures the effect that an additional extreme price event in a given rating category has on the other countries that belong to it, all other things equal.

5.2 Evidence on 'signalling austerity'

In the first empirical strategy I estimate equation (5.1) by OLS:

$$Y_{i,t} = \alpha + \beta Corr_t + \gamma X_{i,t-1} + \kappa_i + \epsilon_{i,t},$$

where $Y_{i,t}$ is one of the several fiscal variables that proxy for austerity, $Corr_t$ is the rank correlation variable and $X_{i,t-1}$ are one period-lagged control variables (the fiscal variables explained above, debt over GDP, squared debt over GDP, log fiscal GDP, log GDP per capita and growth). The specification includes country fixed effects.

As it can be seen in table 1, the estimated value of β is significant and has the expected sign. A decrease in the correlation is associated with the following: an increase in net lending, as well as in the primary budget balance and in potential structural balance and a decrease in government spending. Effects are small (a 1% decrease in the correlation implies a 0.03 reduction in percentage points of net borrowing over GDP) but statistically significant as reported in table 1.

As a robustness check in Appendix K I repeat the same regression (5.1) on the sample splited by regions (OECD countries, European Union countries, peripheral European countries named 'PIGS' and emerging market economies). The effect of a decrease in the

Table 1: OLS regression results with robust standard errors

	Dependent Variable			
	Net borrowing	Primary deficit	Structural deficit	Expenditure
Correlation	-0.0337***	-0.0298***	-0.0169**	0.0327***
	(0.00890)	(0.00866)	(0.00716)	(0.00874)
Lag net borrowing	0.177	-0.693***	-0.286***	0.439***
	(0.141)	(0.139)	(0.105)	(0.113)
Lag primary deficit	0.281***	1.167***	0.214**	-0.152*
	(0.101)	(0.101)	(0.0839)	(0.0835)
Lag expenditure	-0.0307	-0.00929	-0.0493	0.807***
	(0.0559)	(0.0578)	(0.0496)	(0.0548)
Lag structural deficit	0.366***	0.301***	0.807***	-0.299***
	(0.0891)	(0.0883)	(0.0565)	(0.0855)
Lag debt	0.0539**	0.0571***	0.0386***	-0.0295
	(0.0217)	(0.0211)	(0.0135)	(0.0185)
Lag square debt	-0.000170*	-0.000191**	-0.000113**	0.000104
	(0.0000893)	(0.0000875)	(0.0000562)	(0.0000785)
Lag logGDP	-0.290	-0.689	0.0183	0.518
	(0.580)	(0.664)	(0.582)	(0.565)
Lag logGDPpc	2.524	3.016	-0.382	-2.839*
	(1.648)	(1.834)	(1.507)	(1.647)
Lag growth	10.03**	9.283**	1.465	-5.603
	(3.996)	(3.994)	(3.474)	(3.563)
Country FE	yes	yes	yes	yes
N	670	669	670	670
r2	0.813	0.745	0.847	0.962
F	49.11	37.51	61.51	612.0

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

correlation is qualitatively the same, however, it becomes less significant for the group of PIGS and it is not significant for emerging markets. According to the model, this can be expected if there is a higher proportion of type B countries in the two groups relative to the OECD and EU groups.

The right-hand-side of regression (5.1) is a time aggregate and the left-hand-side is individual data, hence reverse causality from a given country austerity $Y_{i,t}$ to $Corr_t$ is unlikely. Nevertheless, I replace $Corr_t$ in (5.1) by the rank correlation calculated over a random subsample constituted by half of the countries (J) in the sample and estimate the following regression for the other countries:

$$Y_{i,t} = \alpha + \beta Corr_t^J + \gamma X_{i,t-1} + \kappa_i + \epsilon_{i,t} \; \forall i \notin J. \tag{5.3}$$

with OLS. In (5.3) the fiscal position $Y_{i,t}$ cannot affect the correlation $Corr_t^J$ as a consequence of the computation method because they belong to different groups. Table 2 shows that the effect found in the previous regressions holds.

In table 3 I present the results of the following specification:

$$Y_{i,t} = \alpha + \beta Corr_{t-1} + \gamma X_{i,t-1} + \kappa_i + \epsilon_{i,t}, \tag{5.4}$$

where I have substituted $Corr_t$ by its one period lag. In order to deal with error autocorrelation, regression (5.4) has been estimated using the Arellano-Bond GMM estimation. [19] The $Corr_{t-1}$ is instrumented with further lags of the same variable. As reported in table 3, there is no autocorrelation left in the residuals. $X_{i,t-1}$ contains the lagged dependent variable, debt over GDP, squared debt over GDP, log fiscal GDP, log GDP per capita and growth. I also apply the correction for small samples. Results confirm the previous ones and are significant.

[19] The idea is that the correlation at $t-1$ is predetermined when looking at it from the current period and, hence, it can not be affected by the austerity that takes place at period t. The Arellano-Bond estimator in differences uses first differentiation to eliminate the autocorrelated fixed component of the error term.

Table 2: OLS regression results with robust standard errors

	Dependent Variable			
	Net borrowing	Primary deficit	Structural deficit	Expenditure
Correlation^J	-0.0462***	-0.0451***	-0.0149*	0.0318***
	(0.0105)	(0.0106)	(0.00831)	(0.0100)
Lag net borrowing	0.253	-0.564***	-0.117	0.109
	(0.178)	(0.173)	(0.172)	(0.172)
Lag primary deficit	-0.0241	0.769***	0.133	0.165
	(0.136)	(0.134)	(0.131)	(0.131)
Lag expenditure	-0.0898	-0.00860	-0.0495	0.734***
	(0.0748)	(0.0758)	(0.0799)	(0.102)
Lag structural deficit	0.544***	0.567***	0.694***	-0.325**
	(0.104)	(0.0954)	(0.143)	(0.140)
Lag debt	0.0919***	0.0893***	0.0434**	-0.0501**
	(0.0247)	(0.0247)	(0.0191)	(0.0220)
Lag square debt	-0.000309***	-0.000324***	-0.000126*	0.000202**
	(0.0000943)	(0.0000936)	(0.0000752)	(0.0000861)
Lag logGDP	-2.405***	-3.806***	-0.853	1.833
	(0.672)	(0.760)	(1.235)	(1.137)
Lag logGDPpc	6.881***	9.682***	1.308	-4.754*
	(1.803)	(1.923)	(3.023)	(2.822)
Lag growth	9.130**	9.545**	1.321	-4.470
	(4.570)	(4.672)	(6.018)	(4.431)
Country FE	yes	yes	yes	yes
N	306	305	306	306
r2	0.783	0.781	0.804	0.970
F	55.26	48.51	51.03	679.9

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 3: Arellano Bond GMM regression results

	Dependent Variable			
	Net borrowing	Primary deficit	Structural deficit	Expenditure
Lag correlation	-0.0410***	-0.0377***	-0.0346***	0.0266***
	(0.00853)	(0.0103)	(0.00883)	(0.00721)
Lag net borrowing	0.421***			
	(0.0938)			
Lag primary deficit		0.334***		
		(0.0767)		
Lag structural deficit			0.653***	
			(0.0972)	
Lag expenditure				0.646***
				(0.102)
Lag debt	0.178*	0.338***	0.134	-0.144
	(0.104)	(0.114)	(0.0805)	(0.125)
Lag square debt	-0.000632	-0.00127*	-0.000372	0.000306
	(0.000579)	(0.000640)	(0.000569)	(0.000639)
Lag logGDP	0.0269	-4.672*	2.483	2.283
	(2.323)	(2.788)	(1.997)	(3.550)
Lag logGDPpc	1.202	13.58	-9.046	-5.635
	(7.505)	(8.456)	(6.014)	(11.86)
Lag growth	27.97***	31.37***	9.734**	-10.41
	(6.807)	(8.031)	(3.920)	(6.505)
N	1182	947	733	1184
hansen	58.28	50.63	35.10	58.78
ar2p	0.640	0.953	0.0235	0.699
F	21.67	13.53	34.51	24.99

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Next, I instrument $Corr_t$ with the annual stock prices of the company Moody's. Moody's is the only big rating agency that is quoted since 1998 in the stock exchange with the ticker MCO. Since the ratings are very similar across rating agencies (correlation coefficient of 98%) I assume that so is the perception about the informativeness of the agencies. See in figure 7 the evolution of Moody's stock prices plotted against the number of news retrieved from major distribution newspapers (in English language) that contain a negative view on the rating agencies.[20] Since the year 2007 the articles critical with the ratings agencies become more numerous and that coincides with a step decrease in the stock valuation of the company Moody's. In 2012, though, the increasing trend of bad news reverts and the stock climbs back a large part of the previous decrease. The visibility of negative opinions about the rating agencies may have played a role in the evolution of Moody's stock prices.

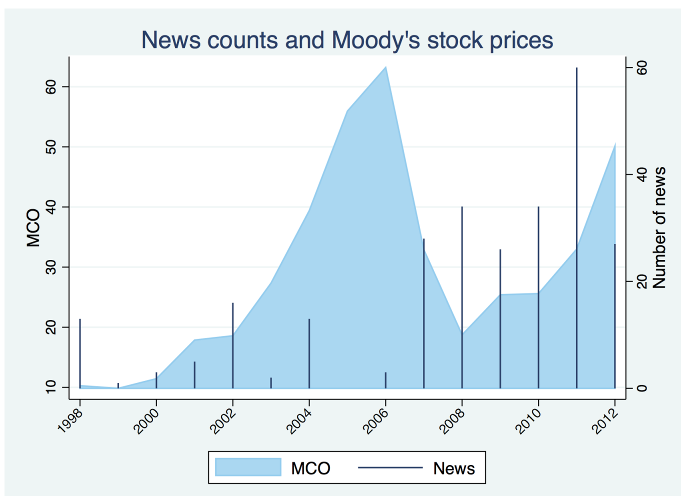


Figure 7: News counts on CRA's reputation and the relation to Moody's stock prices.

Thus, the assumption here is that Moody's prices reflect the ability of the agency to assign informative ratings. The relevance of the prices to explain the $Corr_t$ can further be assessed by looking at the results of the first stage instrumental variables regression in table 4.

[20]Seach key words were 'rating agencies, reputation, accuracy & criticism', 'rating agencies, credibility & mistake or error or blame', 'rating agencies, reputation & regulation' and an example of article would be: 'Rating agencies: Capable or culpable?', Euromoney November 2007.

Table 4: First stage instrumental variable regression results

	Dependent Variable			
	Lag correlation	Lag correlation	Lag correlation	Lag correlation
Lag MCO	-0.144***	-0.135***	-0.144***	-0.141***
	(0.0191)	(0.0208)	(0.0231)	(0.0188)
Lag net borrowing	-0.159*			
	(0.0964)			
Lag primary deficit		-0.123		
		(0.0990)		
Lag structural deficit			-0.111	
			(0.166)	
Lag expenditure				0.302***
				(0.0823)
Lag debt	0.0830*	0.141***	0.177***	0.0823**
	(0.0428)	(0.0485)	(0.0541)	(0.0415)
Lag square debt	0.0000364	-0.0000432	0.000136	-0.0000107
	(0.000217)	(0.000230)	(0.000271)	(0.000215)
Lag logGDP	13.74***	12.86***	12.25***	13.23***
	(1.299)	(1.542)	(1.801)	(1.292)
Lag logGDPpc	11.79***	16.25***	24.64***	11.35***
	(4.064)	(4.761)	(5.231)	(4.035)
Lag growth	-40.83***	-52.63***	-56.46***	-38.70***
	(8.166)	(9.377)	(10.72)	(7.888)
Country FE	yes	yes	yes	yes
N	855	698	555	857
r2	0.447	0.477	0.485	0.455
F	9.067	9.511	9.711	9.360

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

On the other hand, Moody's prices should not directly affect any given country's willingness to do austerity. Except through the indirect effect of stock prices on the correlation that impacts austerity via the signalling channel. In table 5 results are confirmed for all proxies of austerity at the 99% significance, though the magnitude of the effect is larger than in the previous estimations.

The previous results might be affected by omitted variable bias, e.g. global uncertainty. Imagine that we were estimating this regression:

$$Y_{i,t} = \alpha + \beta Corr_t + \gamma X_{i,t-1} + \kappa_i + \epsilon_{i,t}, \tag{5.5}$$

where in reality $\epsilon_{i,t} = Z_t + u_{i,t}$ and $Corr(X_{i,t-1}, Z_t) \neq 0$. Global uncertainty Z_t might affect the $Corr_t$ because it makes the yields less predictable and, at the same time, it induces countries to do more austerity, for instance for precautionary motives. Then, $Corr(X_{i,t-1}, \epsilon_{i,t}) \neq 0$ and estimation by OLS would produce biased coefficients.

The second empirical strategy of equation (5.2) addresses the issue of omitted global factors. First I find in the dataset *large* price changes without a change in the rating: the variable Price $\text{Shock}_{i,k,t-1}$ captures a change to the price of country i that belongs to the rating category k in year $t-1$. Rating categories have been defined more coarsely than the rating grades in order to obtain a large number of countries in each category.[21] I define a price change to be *large* when the changes in demeaned log yields in two consecutive years are larger than two standard deviations of the log yields distribution in that year for that rating category. [22] I use log yields because first, the distribution of yield changes is smoother (otherwise the majority of data points is concentrated around the mean) and, secondly, the interpretation of differences in log yields as percentage changes is useful and more realistic: it has the consequence that the same difference in yield points represents a larger percentage

[21]The rating categories are: 'Prime' for ratings between AAA and AAA- included, 'Subprime' for ratings between Aa1+ and Aa3- included, 'Investment' between A1+ and Baa3- and 'Non-investment' lower or equal to Ba1+.

[22]This is robust to small changes in the threshold of standard deviations.

Table 5: Instrumental variable regression results

	Dependent Variable			
	Net borrowing	Primary deficit	Structural deficit	Expenditure
Lag correlation	-0.323***	-0.358***	-0.152***	0.232***
	(0.0552)	(0.0687)	(0.0406)	(0.0479)
Lag primary deficit		0.475***		
		(0.0457)		
Lag structural deficit			0.606***	
			(0.0433)	
Lag expenditure				0.584***
				(0.0346)
Lag net borrowing	0.442***			
	(0.0427)			
Lag debt	0.0332*	0.0994***	0.0579***	-0.0314**
	(0.0181)	(0.0234)	(0.0153)	(0.0152)
Lag square debt	-0.0000663	-0.000242**	-0.0000480	0.000129*
	(0.0000909)	(0.000103)	(0.0000690)	(0.0000771)
Lag logGDP	2.983***	2.063*	-0.275	-1.887**
	(0.900)	(1.077)	(0.644)	(0.758)
Lag logGDPpc	2.114	5.907***	3.898***	0.193
	(1.694)	(2.215)	(1.494)	(1.436)
Lag growth	-4.587	-13.00**	-5.466	7.302**
	(4.372)	(6.087)	(3.813)	(3.649)
Country FE	yes	yes	yes	yes
N	855	698	555	857
r2	0.523	0.518	0.757	0.941
F	17.05	15.81	34.86	182.7

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

change for lower yields than for higher ones. This feature seems particularly true for countries with good funding rates, where a change in yields may double the current rate, whereas for countries already paying higher yields the same change might represent a smaller effect. Demeaning allows me to get rid of the time trend in the time series of yields.

Then I calculate the number of *large* price changes in one year in one rating category and how it affects the fiscal position one year ahead of the other countries in the same rating category that did not have a shock. The regression I estimate is the following:

$$Y_{j,k,t} = \alpha + \beta \text{Price Shocks}_{i,k,t-1} + \gamma X_{j,t-1} + \kappa_j + \delta_t + u_{j,t},$$

$\forall j \neq i$ in the same k. In (5.2) the omitted variable Z_t is now captured by the time dummy.

I excluded from the estimation countries that had a price change or a rating change so that in this specification the dependent variable is exogenous to the countries' fiscal position. The effect on austerity is assumed to come from the change in CRA informativeness. $X_{j,t}$ includes the usual controls and, additionally, the lagged log yield and the lagged rating. This is trying to control for any other domestic reason that affects the fiscal stance.

Regression (5.2) deals with omitted variable bias even if it has asymmetric effects on different rating categories because the category performing higher austerity changes every time (depending on the category that experienced the price change). The regression results for this specification are presented in table 6. Notice that experiencing a price change (or more) means a larger number in the variable Price $\text{Shocks}_{i,k,t-1}$, hence, an increase in the explanatory variable should be associated with more austerity (a positive coefficient for net lending and budget balance variables and a negative one for government expenditure). Results are confirmed by these approach. The coefficients continue to be statistically significant although the significance has dropped for government spending. Being subject to a *large* price change in the rating category increases the austerity over GDP in the order of a quarter to a half percentage points depending on the measure we are looking at.[23]

[23] An example with the primary deficit would be going from 3.5% over GDP to 3%.

Table 6: OLS regression results with robust standard errors

	Dependent Variable			
	Net borrowing	Primary deficit	Structural deficit	Expenditure
Lag price shocks	0.478***	0.510***	0.241**	-0.225*
	(0.156)	(0.168)	(0.119)	(0.127)
Lag net borrowing	0.721***			
	(0.0426)			
Lag primary deficit		0.768***		
		(0.0417)		
Lag structural deficit			0.722***	
			(0.0563)	
Lag expenditure				0.774***
				(0.0317)
Lag debt	-0.00481	0.00633	-0.00344	0.0109*
	(0.00605)	(0.00622)	(0.00639)	(0.00572)
Lag logGDP	-2.521	-3.715	-6.441**	-0.318
	(2.792)	(3.072)	(3.026)	(2.439)
Lag logGDPpc	0.523	2.997	5.393*	3.760
	(2.915)	(3.390)	(2.877)	(2.546)
Lag growth	5.544	1.780	7.546	-4.933
	(4.223)	(4.687)	(6.468)	(3.884)
Log yields	0.215	0.766	0.972	0.0617
	(0.436)	(0.518)	(0.640)	(0.401)
Rating	-0.0807	-0.100	-0.101**	0.0355
	(0.0554)	(0.0643)	(0.0493)	(0.0478)
Country FE	yes	yes	yes	yes
Time FE	yes	yes	yes	yes
N	725	637	577	725
r2	0.845	0.833	0.846	0.978
F	46.97	39.81	88.45	748.7

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

In appendix L, I present the list of countries that experienced a *large* price change.

5.3 Alternative explanations

There could be alternative theories that explain the empirical results obtained in the previous section. I attempt to address them in this section.

First, in order to rule out that austerity is due to criteria of budget sustainability, I have controlled in all the regressions above for a set of individual characteristics that the literature has identified as important. Concerns about omitted global variables, that affect all the countries at the same time, are addressed including country and time fixed effects in the last specification. The effect of changes in informativeness on austerity remains after the global variables are controlled for.

But there could also be omitted variables that affect only some countries and not others. Particularly problematic is the case when this omitted variable affects the countries in some particular category only. In this case the effects can be confounded with the effects of the *large* price changes operating at the level of the rating category and we would be unsure whether we are capturing the correct effect. For example, think about precautionary savings by rating category triggered by uncertainty clustered at the category level. Notice, though, that the 'savings glut' should be homogenous in all countries affected by the precautionary motive. But austerity by category shows high dispersion. Thus, it indicates that austerity is not performed by every country as consistent with the precautionary motive but only by some countries, that belong in the category affected by a price change, as consistent with the signalling motive.

Finally, the result can also be attributed to contagion. A shock to a country transmits to others, even though they are not directly affected by it. By the nature of contagion, it cannot be captured controlling for the fundamentals of the country as I did before. In order to detect contagion from the risk of one country to another one, the literature relies usually in price comovements, thus, implying that contagion should indeed show in the price of debt.

Including the own debt price in the last specification, as it is shown in table 6, I still find an effect of changes in the informativeness.

6 Conclusion and policy discussion

In this paper I show that a sovereign may use fiscal policy as a signal to communicate its high ability to repay to the lenders. When good ratings are less capable of improving the market perception about a country, I find that sovereigns are prone to a higher austerity. This result is robust to different empirical strategies, specifications and variables that proxy for austerity. I consistently find evidence that favours the signalling channel to other alternative explanations.

The findings in this paper might be useful to inform policymakers about the financial market regulation in order to target stabilisation of the debt markets and avoid sovereign crisis. A particular measure that has been argued during the recent debt crisis in Europe has been introducing a common debt ceiling. For instance, the Fiscal Compact has introduced the rule of the fiscal budget balance in its article 3 of title II.[24] In the model this policy is equivalent to setting an exogenous limit to debt, that is the same for any country type. This policy is relevant only when the debt ceiling $\bar{D}_2$ is lower than type B's full information allocation D_2^{FI} as in figure 8. Imagine a situation where the equilibrium is the separating one e^*. Once the debt ceiling is introduced, type B is not allowed to choose its optimal debt level because it would violate the rule. In a separating equilibrium in the new circumstances, type B chooses the highest amount of debt possible, $\bar{D}_2$, as depicted in figure 9. But this brings type B to a lower indifference curve, thereby forcing type A to choose an even lower amount of debt than D_2^{-B}. Type A needs to do more austerity in order to avoid imitation from B because the outside option for B has become worse. Both types are worse off, even

[24] "*The Contracting Parties shall apply the rules set out in this paragraph in addition and without prejudice to their obligations under European Union law: (a) the budgetary position of the general government of a Contracting Party shall be balanced or in surplus; [...] (e) in the event of significant observed deviations from the medium-term objective or the adjustment path towards it, a correction mechanism shall be triggered automatically.*"

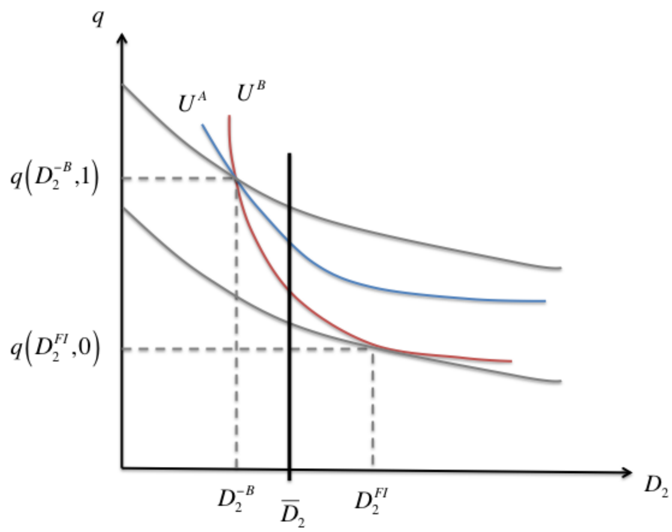


Figure 8: A common debt ceiling at $\bar{D}_2$.

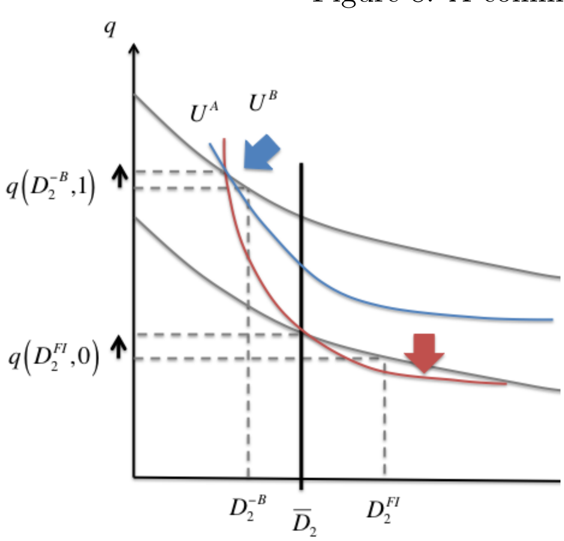


Figure 9: Separating equilibrium with a common debt ceiling.

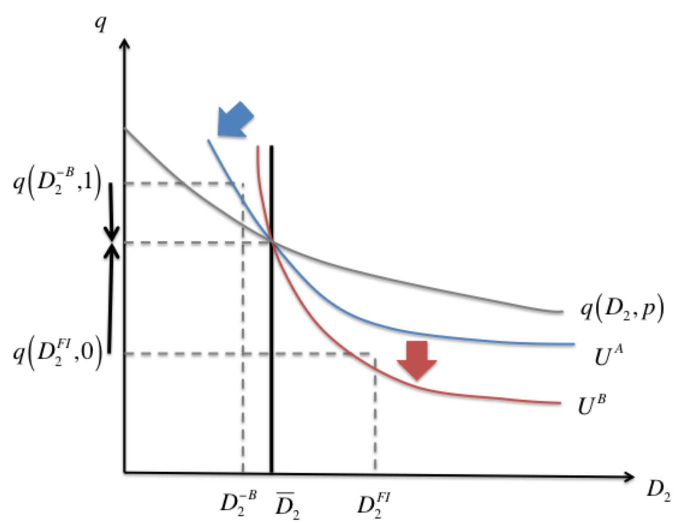


Figure 10: Pooling equilibrium with a common debt ceiling.

though the price of debt improves because the sovereign has a lower default probability.

But, given that type A's utility has changed, the separating equilibrium in figure 9 might be defeated by a pooling. In figure 10 the pooling equilibrium at $\bar{D}_2$ makes both types better off, thus the separating is defeated and any sovereign chooses $\bar{D}_2$. Comparing with the initial equilibrium without the debt ceiling in figure 8, though, every country type looses. This can be seen comparing the utility levels of type A and B with the equilibrium allocations from figure 8 represented by the dotted lines. Moreover, type B's default premium decreases but A's increases, as the black arrows in the vertical axis show, leaving open the possibility that the overall probability of default increases or decreases. It is, therefore, possible that the introduction of a debt ceiling makes all countries worse off and it does not improve the situation of the creditors either. A 'one-size-fits-all' austerity program as the Fiscal Compact may backfire when countries are trying to signal with austerity.[25]

In the midst of the current debate on austerity, the question about its optimal amount is in the forefront of the research and policy agenda. It is, therefore, important to understand all the different roles that austerity might play. In this paper I have stressed one of these roles, complementary to others shown in the literature, of fiscal austerity: the signalling role.

[25] In a different set-up with homogeneous countries and limited commitment, introducing a debt ceiling could instead be useful to relax the commitment problem.

APPENDIX

A Full information optimal allocation

Let us show that the optimal level of debt under full information D_2^{FI} is a local maximum. Derivating the FOC (3.2) with respect to D_2 and rearrenging gives:

$$F''\left(D_2 + \underline{c}^i\right)\left[-\beta' D_2 - \beta' \frac{F'\left(D_2 + \underline{c}^i\right)}{F''\left(D_2 + \underline{c}^i\right)} + (\beta' - \beta)h^{-1}\right]. \tag{A.1}$$

In order to sign the previous expression, substitute $F(\omega)$ for its functional form $1 - e^{-h\omega - \underline{\omega}}$. $F''(\omega) < 0$ and for equation (A.1) to be negative it must be that

$$-\beta' D_2 - \beta' \frac{F'\left(D_2 + \underline{c}^i\right)}{F''\left(D_2 + \underline{c}^i\right)} + (\beta' - \beta)h^{-1} > 0,$$

therefore,

$$D_2 < \frac{\beta' - \beta}{\beta' h} + \frac{1}{h}. \tag{A.2}$$

The derivative of the FOC is negative when (A.2) holds. Since $D_2^{FI} = \frac{\beta' - \beta}{\beta' h}$ and $h > 0$, the expression (A.1) is negative at D_2^{FI} and D_2^{FI} is a local maximum.

B The single crossing property

The definition of *single crossing* preferences is the following: $U^i(D_2, q; \omega_1 - D_1)$ satisfies the *single crossing* condition if $U^B(D_2, q) \leq U^B(D_2', q')$ for $D_2' < D_2$ implies that $U^A(D_2, q) \leq U^A(D_2', q')$ (Sobel, 2009). Geometrically it is equivalent to a ranking of the slopes of the indifference curves $\Delta^A > \Delta^B$, where

$$\Delta^i = -\frac{\frac{\partial U^i(D_2,q)}{\partial D_2}}{\frac{\partial U^i(D_2,q)}{\partial q}}. \tag{B.1}$$

Let us show that the slope of country type B's indifference curves is higher than that of A's for the relevant range of D_2. First, let us find the threshold level of debt that satisfies constraint (2.5) for $t = 1$ for each type:

$$\underline{D}_2^i = \frac{\underline{c}^i - \omega_1 + D_1}{\beta' \left[1 - F(\underline{D}_2^i + \underline{c}^i)\right]}. \tag{B.2}$$

Substituting $F(\cdot)$ for its functional form,

$$\underline{D}_2^i = \frac{\underline{c}^i - \omega_1 + D_1}{\beta'} e^{h(\underline{c}^i - \underline{\omega})} e^{h\underline{D}_2^i}, \tag{B.3}$$

$e^{h\underline{D}_2^i}$ is bounded between 0 and 1 and, therefore, $\underline{D}_2^i > 0$. Moreover, since $\underline{c}^A < \underline{c}^B$, $\underline{D}_2^A < \underline{D}_2^B$. So the range of interest of D_2 is between $\underline{D}_2^B$ and ∞.

Next, let us compute Δ^i for each type. Total differentiation of (2.8) gives:

$$0 = D_2 \cdot dq +$$
$$+ \left[q + \beta F'(D_2 + \underline{c}^i)\underline{c}^i - \beta F'(D_2 + \underline{c}^i)(D_2 + \underline{c}^i) + \beta F'(D_2 + \underline{c}^i) D_2 - \beta\left(1 - F(D_2 + \underline{c}^i)\right)\right] \cdot dD_2$$

and, simplifying,

$$0 = D_2 \cdot dq + \left[q - \beta\left(1 - F(D_2 + \underline{c}^i)\right)\right] \cdot dD_2.$$

Therefore, $\Delta^i = -\frac{q - \beta\left(1 - F(D_2 + \underline{c}^i)\right)}{D_2}$ and $\Delta^A < \Delta^B$ if $\Delta^i < 0$, which is the case for all $D_2 \in [\underline{D}_2^B, 0)$ given assumption (C4).

C Separating equilibrium

Define first D_2^{-B} as the debt levels where type B's indifference curve going through the full information allocation crosses price schedule $q(\cdot, 1)$,

$$U^B(D_2^{-B}, q(D_2^{-B}, 1)) = U^B(D_2^{FI}, q(D_2^{FI}, 0)), \tag{C.1}$$

and $D_2^{A,B}$ as A's preferred allocation under the price schedule $q(D_2, 0)$.

Define also $\mathbf{q}_i(D_2, U)$ as the indirect function that gives the price of debt necessary to keep type i's utility constant U for a given debt D_2. If $\bar{U} = U^B(D_2^{FI}, q(D_2^{FI}, 0))$ is the utility level of country B in the full information equilibrium, $\mathbf{q}_B(D_2^{FI}, \bar{U})$ is equal to the price schedule $q(D_2^{FI}, 0)$ by definition. On the other hand, we know that $q(D_2, 0) < q(D_2, 1) \quad \forall D_2$ and, in particular, for D_2^{FI}. Therefore,

$$\mathbf{q}_B(D_2^{FI}, \bar{U}) = q(D_2^{FI}, 0) < q(D_2^{FI}, 1).$$

Hence, for D_2^{FI}, $\mathbf{q}_B(D_2^{FI}, \bar{U})$ lies below $q(D_2^{FI}, 1)$. Now let us check how these functions behave to the left of D_2^{FI}:

$$q(\underline{D}_2^B, 1) = \beta' \left[1 - F(\underline{D}_2^B + \underline{c}^A)\right] > 0$$

and

$$\lim_{D_2 \to \underline{D}_2^B} \mathbf{q}_B(D_2, \bar{U}) = +\infty.$$

In the limit $\mathbf{q}_B(D_2, \bar{U})$ is above $q(D_2, 1)$. Since $q(., 1)$ is continuous in D_2 and so is $\mathbf{q}_B(D_2, \bar{U})$ for $D_2 \neq 0$, $\mathbf{q}_B(D_2, \bar{U}^{B*})$ and $q(D_2, 1)$ must intersect at some D_2 between $\underline{D}_2^B$ and D_2^{FI}. Hence, there exists a $D_2^{-B} \in [\underline{D}_2^B, D_2^{FI}]$ such that the indifference curve of B going through $\left(D_2^{FI}, q(D_2^{FI}, 0)\right)$ crosses the price schedule $q(D_2, 1)$.

It remains to be proved that type A prefers choosing D_2^{-B} and having the price of debt $q(D_2^{-B}, 1)$ to choosing $D_2^{A,B}$ and having the price $q(D_2^{A,B}, 0)$. First, notice that at the full information allocation type B is at its maximum, hence, it is at its highest indifference curve under the $q(D_2, 0)$ schedule. If follows that the price schedule $q(D_2, 0)$ must lie below B's indifference curve going through the full information allocation. So, in order to satisfy the optimality of $D_2^{A,B}$ for type A, $(D_2^{A,B}, q(D_2^{A,B}, 0))$ must be below the indifference curve of B going through $(D_2^{FI}, q(D_2^{FI}, 0))$. And, given that the indifference curve of A is steeper than that of B for any D_2, the two curves can only cross to the right of $D_2^{A,B}$. Since they cannot cross to the left of $D_2^{A,B}$ it is impossible that $(D_2^{A,B}, q(D_2^{A,B}, 0))$ is in a higher indifference curve of A than $(D_2^{-B}, q(D_2^{-B}, 1))$.

D Pooling equilibrium at D_2^{FI}

In order to show that there can be a pooling equilibrium at the full information debt level notice that B's utility at $(D_2^{FI}, q^*(D_2^{FI}, p))$ must be higher than the full information allocation $(D_2^{FI}, q^*(D_2^{FI}, 0))$ because the debt level is the same but the price is better. Thus, type B's optimal choice is $D_2^*(B) = D_2^{FI}$. At the same time, A's utility at $(D_2^{FI}, q^*(D_2^{FI}, p))$ also needs to be higher than at its preferred allocation under $q(D_2, 0)$ schedule, $(D_2^{A,B}, q(D_2^{A,B}, 0))$. By contradiction, for $(D_2^{A,B}, q(D_2^{A,B}, 0))$ to be preferred, U^A going through it must cross $q(\cdot, p)$ at some point between $D_2^{A,B}$ and $D_2^{FI}]$. At $D_2^{A,B}$, $q(D_2^{A,B}, p) > q(D_2^{A,B}, 0)$ and, as $D_2 \to \infty$, the $\lim_{D_2 \to \infty} q(D_2, p) > 0$ and the indifference curve going through $(D_2^{A,B}, q(D_2^{A,B}, 0))$ goes to 0. Continuity and monotonicity of $q(D_2, p)$ is straightforward and of the indifference curve has been shown in appendix A. Hence, they can not cross to the right of $D_2^{A,B}$ and D_2^{FI} is the B's optimal choice. D_2^{FI} is the optimal choice of both A and B given the system of beliefs and, therefore, by Bayes' rule, $\mu = p$ at D_2^{FI}.

E Definition of the Undefeated Equilibrium refinement

Let $e^* = \{(D_2^*(i), q^*; \mu^*(\cdot))\}_{i \in \{A,B\}}$ and $e' = \{(D_2'(i), q'; \mu'(\cdot))\}_{i \in \{A,B\}}$ be two equilibria of the game and let:

1. D_2' be a non-equilibrium outcome in e^*.

2. $\Theta = \{\{A\}, \{B\}, \{A, B\}, \{\emptyset\}\}$ be the set of types that choose strategy D_2' in e'.

3. Denote the utility of type i under equilibrium e: $U^i(e)$. Let $U^i(e') \geq U^i(e) \, \forall i \in \Theta$ with the inequality being strict for at least one $i \in \Theta$.

4. The off-equilibrium beliefs after observing D_2' in e^* be positive for the type(s) with a strict inequality and zero for the type(s) not belonging to Θ.

Then, if $\mu(D_2')$ do not support e^*, e^* is *defeated* by e'.

F Pooling debt allocation preferred by $i \in \{A, B\}$

Recall the FOC (3.2) of the country problem:

$$\frac{\partial q(D_2, \mu)}{\partial D_2} D_2 + q(D_2, \mu) - \beta \left(1 - F(D_2 + \underline{c}^i)\right) = 0.$$

Given that we are focusing on pooling equilibria, the price schedule in equilibrium is

$$q(D_2, p) = \beta' \left[p \left(1 - F(D_2 + \underline{c}^A)\right) + (1 - p) \left(1 - F(D_2 + \underline{c}^B)\right)\right].$$

Plugging this equation into the FOC we obtain:

$$-\beta' \left[pF'(D_2 + \underline{c}^A) + (1 - p)F'(D_2 + \underline{c}^B)\right] D_2 + \beta' \left[p \left(1 - F(D_2 + \underline{c}^A)\right) + (1 - p) \left(1 - F(D_2 + \underline{c}^B)\right)\right] - \\ - \beta \left(1 - F(D_2 + \underline{c}^A)\right) = 0.$$

Hence,

$$D_2^{*i} = h^{-1} - \frac{\beta(1 - F(D_2^{*i} + \underline{c}^A))}{\beta' \left[pF'(D_2^{*i} + \underline{c}^A) + (1-p)F'(D_2^{*i} + \underline{c}^B)\right]}$$

and

$$D_2^{*A} < D_2^{FI} < D_2^{*B}.$$

G Selection of the separating equilibrium e^*

The separating equilibrium e^* must be undefeated. e^* is defeated if there is an equilibrium e' whose μ' at D_2' is not consistent with e^*. Notice that this can only happen:

- To the right of D_2^{-B} if $\forall D_2 \in [\underline{\mathrm{D}}_2^B, D_2^{-B}] \quad q(D_2, \mu) > q(D_2, 1)$, which is impossible according to the definition of PBE.
- To the left of D_2^{-B} any possible equilibria is of pooling type. Hence, equilibrium beliefs are $q(D_2, \mu) = q(D_2, p)$ and $q(D_2, p)$ needs to be above the indifference curve of A going through $\left(D_2^{-B}, q(D_2^{-B}, 1)\right)$.

Thus, $q(D_2, p) < q(D_2, \bar{U}^A)$, where $\bar{U}^A = U^A\left(D_2^{-B}, q(D_2^{-B}, 1)\right)$, is the condition for e^* to survive. The condition holds for a sufficiently low p:

$$p < 1 + \frac{\bar{U}^A - \omega_1 + D_1 + (2\beta - \beta')\left(1 - F(D_2 + \underline{c}_A)\right) - \beta(1 + \underline{c}_A + D_2 + h^{-1})}{\beta' D_2 \left(F(D_2 + \underline{c}_B) - F(D_2 + \underline{c}_A)\right)}.$$

Now, take e^* that is undefeated. This means that $U^i(e^*) \geq U^i(e')\,\forall i$, with strict inequality for at least one i, for any other equilibria e'. Thus, off-equilibrium beliefs in e' must be $\mu'(D_2) \neq 1\,\forall D_2 \neq D_2'$ in order to be able to sustain e'. But, since $\Theta = \{A\}$ at D_2^{-B}, $\mu'(D_2^{-B}) = 1$ and any e' is defeated by e^*.

H Selection of the pooling equilibria

A pooling equilibrium e' defeats the least cost separating equilibrium e^* if $U^A(e') \geq U^A(e^*)$ and $U^B(e') > U^B(e^*)$. D_2' is not an equilibrium strategy for A in e^* but both types choose D_2' in e', hence $\Theta = \{A, B\}$. Off-equilibrium beliefs about the type(s) that choose D_2' in e^* cannot be zero for type B and need to be positive for both A and B. Hence,

$$\mu^*(\cdot) = \begin{cases} p & \text{if } D_2^* \\ 1 & \text{if } D_2^{A,B} \\ 0 & \text{otherwise.} \end{cases}$$

Condition $U^B(D_2^{FI}, q^*(D_2^{FI}, p)) > U^B(D_2^{FI}, q^*(D_2^{FI}, 0))$ is clearly true. And for $U^A(D_2^{FI}, q^*(D_2^{FI}, p)) \geq U^A((D_2^{-B}, q^*(D_2^{-B}, 1))$ it suffices to choose a p that is close to 1. Take, for example, $1 - \epsilon$, where ϵ is very small. Notice that

$$U^A(D_2^{FI}, q^*(D_2^{FI}, p)) = p \left[U^A \left(D_2^{FI}, q^*(D_2^{FI}, 1)\right)\right] + (1-p) \left[U^A \left(D_2^{FI}, q^*(D_2^{FI}, 0)\right)\right]$$

and

$$U^A \left(D_2^{FI}, q^*(D_2^{FI}, 1)\right) > U^A \left(D_2^{-B}, q^*(D_2^{-B}, 1)\right),$$

because it is the full information solution, and

$$U^A \left(D_2^{FI}, q^*(D_2^{FI}, 1)\right) > U^A \left(D_2^{-B}, q^*(D_2^{-B}, 1)\right)$$

as it has been shown in Section 3.2. Thus, using $p = 1 - \epsilon$,

$$\begin{aligned} U^A(D_2^{FI}, q^*(D_2^{FI}, p)) &= (1-\epsilon) \left[U^A \left(D_2^{FI}, q^*(D_2^{FI}, 1)\right)\right] + \epsilon \left[U^A \left(D_2^{FI}, q^*(D_2^{FI}, 0)\right)\right] \\ &> U^A(\left(D_2^{-B}, q^*(D_2^{-B}, 1)\right). \end{aligned}$$

I Dataset: the ratings geography and time span

Country	Moody's	Fitch	S&P	Country	Moody's	Fitch	S&P
Australia	1980	1996	1980	Morocco	1999	2007	1998
Austria	1980	1995	1980	Myanmar	-	-	-
Belgium	1980	1995	1989	Namibia	-	-	-
Botswana	2001	-	2001	Nepal	-	-	-
Bulgaria	1997	1998	1999	Netherlands	1986	1995	1989
Canada	1980	1995	1980	New Zealand	1980	2000	1980
Cyprus	1996	2002	1994	Norway	1980	1995	1980
Czech Republic	1993	1996	1994	Pakistan	1995	-	1995
Denmark	1980	1995	1981	Papua New Guinea	1999	1999	1999
Estonia	1998	1998	1998	Philippines	1994	1999	1994
Ethiopia	-	-	-	Poland	1995	1996	1995
Fiji	1997	-	2007	Portugal	1987	1995	1989
Finland	1980	1995	1980	Romania	1996	1996	1996
France	1980	1995	1980	Russia	1997	1997	1997
Germany	1986	1995	1984	Samoa	-	-	-
Ghana	-	2004	2004	Seychelles	-	2010	2007-09
Greece	1991	1996	1989	Singapore	1990	1999	1989
Guatemala	1998	2006	2002	Slovak Republic	1995	1997	1994
Honduras	1999	-	2009	Slovenia	1996	1997	1996
Hungary	1990	1996	1992	Solomon Islands	-	-	-
Iceland	1989	2000	1989	South Africa	1995	1995	1995
India	1988	2000	1991	Spain	1988	1995	1989
Ireland	1988	1995	1989	Sri Lanka	2011	2006	2006
Italy	1987	1995	1989	Sweden	1980	1995	1980
Jamaica	1998	2007	2000	Switzerland	1982	1995	1989
Japan	1982	1995	1980	Thailand	1990	1998	1989
Korea	1987	1996	1989	Trinidad and Tobago	1993	-	1996
Latvia	1998	1998	1997	Uganda	-	2005	2009
Lithuania	1997	1997	1997	United Kingdom	1980	1995	1980
Luxembourg	1990	1995	1995	United States	1980	1995	1980
Malawi	-	2003-09	-	Vanuatu	-	-	-
Maldives	-	-	-	Venezuela	1980	1998	1980
Malta	1994	1997	1994	Zimbabwe	-	-	-
Mexico	1991	1996	1993				

J Dataset: definition of variables

General government gross debt (Debt, percent of GDP): Gross debt consists of all liabilities that require payment or payments of interest and/ or principal by the debtor to the creditor at a date or dates in the future. This includes debt liabilities in the form of SDRs, currency and deposits, debt securities, loans, insurance, pensions and standardized guarantee schemes, and other accounts payable. Thus, all liabilities in the GFSM 2001 system are debt, except for equity and investment fund shares and financial derivatives and employee stock options. Debt can be valued at current market, nominal, or face values (World Economic Outlook 2013, WEO13).

General government net lending/ borrowing (Netbor, percent of GDP): Net lending (+)/ borrowing (-) is calculated as revenue minus total expenditure. This is a core GFS balance that measures the extent to which general government is either putting financial resources at the disposal of other sectors in the economy and nonresidents (net lending), or utilizing the financial resources generated by other sectors and nonresidents (net borrowing). This balance may be viewed as an indicator of the financial impact of general government activity on the rest of the economy and nonresidents. Note: Net lending (+)/ borrowing (-) is also equal to net acquisition of financial assets minus net incurrence of liabilities (WEO13).

General government primary net lending/ borrowing (Primdef, percent of GDP): Primary net lending/ borrowing is net lending (+)/ borrowing (-) plus net interest payable/ paid (interest expense minus interest revenue) (WEO13).

General government structural balance (Strucdef, national currency): The structural budget balance refers to the general government cyclically adjusted balance adjusted for nonstructural elements beyond the economic cycle. These include temporary financial sector and asset price movements as well as one-off, or temporary, revenue or expenditure items. The cyclically adjusted balance is the fiscal balance adjusted for the effects of the economic cycle (WEO13).

General government structural balance (Strucdefpot, percent of potential GDP): The structural budget balance refers to the general government cyclically adjusted balance adjusted for nonstructural elements beyond the economic cycle. These include temporary financial sector and asset price movements as well as one-off, or temporary, revenue or expenditure items. The cyclically adjusted balance is the fiscal balance adjusted for the effects of the economic cycle (WEO13).

General government total expenditure (Expend, percent of GDP): Total expenditure consists of total expense and the net acquisition of non-financial assets (WEO13).

GDP corresponding to fiscal year, current prices (GDP, billions of national currency): Gross domestic product corresponding to fiscal year is the country's GDP based on the same period during the year as their fiscal data. In the case of countries whose fiscal data are based on a fiscal calendar (e.g., July to June), this series would be the country's GDP over that same period. For countries whose fiscal data are based on a calendar year (i.e., January to December), this series will be the same as their GDP in current prices (WEO13).

GDP growth (Growth, percent): author's own calculation applying the formula $\frac{GDP_t - GDP_{t-1}}{GDP_t}$ to the GDP series corresponding to fiscal year (current prices).

GDP per capita, constant prices (GDPpc, units of national currency): GDP is expressed in constant national currency per person. Data are derived by dividing constant price GDP by total population (WEO13).

K Regression by country groups

Table 7: OLS with robust standard errors

	(1) OECD	(2) EU	(3) PIGS	(4) EM
Net lending/ borrowing	-0.0284***	-0.0350***	-0.0770**	-0.0249
	(0.00885)	(0.0112)	(0.0333)	(0.0233)
N	535	397	93	96
r2	0.823	0.765	0.741	0.761
F	45.38	33.02	14.59	45.21
Primary balance	-0.0258***	-0.0315***	-0.0722**	-0.0272
	(0.00863)	(0.0107)	(0.0319)	(0.0222)
N	534	396	92	96
r2	0.752	0.712	0.733	0.731
F	39.80	32.87	13.86	44.28
Potential structural balance	-0.0107*	-0.0105	-0.0574**	-0.0220
	(0.00645)	(0.00856)	(0.0243)	(0.0182)
N	535	397	93	96
r2	0.848	0.852	0.857	0.853
F	59.24	43.61	22.59	70.95
Government spending	0.0246***	0.0278**	0.0425	0.0246
	(0.00906)	(0.0122)	(0.0282)	(0.0310)
N	535	397	93	96
r2	0.942	0.928	0.840	0.975
F	399.3	249.0	62.09	302.8

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

L Large price changes

NEGATIVE				POSITIVE			
Country	**Year**	**Country**	**Year**	**Country**	**Year**	**Country**	**Year**
Czech Republic	2003	Pakistan	1992	Cyprus	2006	New Zealand	1992
Greece	2010	Portugal	2011	Ethiopia	1987	Norway	1993
Honduras	1994	South Africa	1988	Honduras	1997	Norway	2004
Honduras	1996	Sri Lanka	1991	Italy	1984	Norway	2009
Iceland	2008	Switzerland	1994	Japan	1992	Pakistan	2003
Jamaica	1985	Switzerland	1999	Japan	1997	Seychelles	2003
Jamaica	1990	Switzerland	2003	Japan	1998	Singapore	2007
Japan	1990	Thailand	2004	Japan	2001	Slovenia	1993
Japan	1999	Uganda	1984	Japan	2007	Slovenia	1994
Lithuania	2009	Uganda	1985	Korea	1981	Solomon Islands	2004
Luxembourg	2006	Uganda	1986	Korea	1982	Solomon Islands	2005
Malawi	1995	Uganda	1989	Korea	1983	Switzerland	2000
New Zealand	1996	United States	2005	Latvia	2011	Switzerland	2002
Norway	1998			Lithuania	2010	Switzerland	2008
				Luxembourg	1988	Switzerland	2011
				Mexico	2001	Thailand	1987
				Namibia	2001	Vanuatu	1989
				Nepal	1991	Vanuatu	2008

References

Viral V. Acharya and Raghuram G. Rajan. Sovereign debt, government myopia, and the financial sector. *NBER Working Papers 17542*, 2011.

E. Baldacci, S. Gupta, and C. Mulas-Granados. How effective is fiscal policy response in financial crises? In Stijn Claessens, M. Ayhan Kose, Luc Laeven, and Fabian Valencia, editors, *Financial Crises: Causes, Consequences, and Policy Responses*, pages 431–457. IMF Publication, 2013.

J. S. Banks and J. Sobel. Equilibrium selection in signaling games. *Econometrica*, 55(3): 647–661, 1987.

H. Bar-Isaac and J. Shapiro. Ratings quality over the business cycle. *Journal of Financial Economics*, 108(1):62–78, 2013.

R. Barro. On the determination of the public debt. *Journal of Political Economy*, 87(6): 940–971, 1979.

M. Bussiere and A. Ristiniemi. Credit ratings and debt crisis. *Banque de France document de travail*, 396, 2012.

In-Koo Cho and David M. Kreps. Signaling games and stable equilibria. *Quarterly Journal of Economics*, 102(2):179–221, 1987.

H.L. Cole and T.F. Cooley. Rating agencies. *NBER Working Paper*, 19972, 2014.

G. Cuadra, J.M. Sanchez, and H.. Sapriza. Fiscal policy and default risk in emerging markets. *Review of Economic Dynamics*, 13(2):452–469, 2010.

R. De Santis. The Euro area sovereign debt crisis: safe haven, credit rating agencies and the spread of the fever from Greece, Ireland and Portugal. *European Central Bank Working Paper*, 1419, 2012.

F. Drudi and A. Prati. Signaling fiscal regime sustainability. *European Economic Review*, 44(2):1897–1930, 2000.

C. Favero and T. Monacelli. Fiscal policy rules and regime (in)stability: Evidence from the U.S. *IGIER Working Paper*, 282, 2005.

A. Fostel, L. Catao, and R. Ranciere. Fiscal discoveries and yield decouplings. Working Paper, 2013.

J. Gali and R. Perotti. Fiscal policy and monetary integration in Europe. *Economic Policy*, 18(37):533–572, 2003.

S. Holden, G.J. Natvik, and A. Vigier. An equilibrium model of credit rating agencies. *Norges Bank Working Paper*, 23, 2012.

J. Josepson and J. Shapiro. Credit ratings and security design. *Working Paper*, 2014.

J. Kiff, S. Nowak, and L. Schumacher. Are rating agencies powerful? An investigation into the impact and accuracy of sovereign ratings. *IMF Working Paper*, 12/23, 2010.

G. J. Mailath, M. Okuno-Fujiwara, and A. Postlewaite. Belief based refinements in signaling games. *Journal of Economic Theory*, 60(2):241–276, 1993.

G. Manso. Feedback effects of credit ratings. *Journal of Financial Economics*, 109(2): 535–548, 2013.

J. Mathis, J. McAndrews, and J.C. Rochet. Rating the raters: Are reputation concerns powerful enough to discipline rating agencies? *Journal of Monetary Economics*, 56(5): 657–674, 2009.

C.C. Opp, M.M. Opp, and M. Harris. Rating agencies in the face of regulation. *Journal of Financial Economics*, 108(1):46–61, 2013.

F. Partnoy. How and why credit rating agencies are not like other gatekeepers. In Y. Fuchita and R.E. Litan, editors, *Financial Gatekeepers: Can they protect investors?* San Diego Legal Studies Paper 07-46, 2006.

T. Persson and G. Tabellini. Political economics and public finance. *NBER Working Papers 7097*, 1999.

Guido Sandleris. Sovereign defaults: Information, investment and credit. *Journal of International Economics*, 76(2):267–275, 2008.

V. Skreta and L. Veldkamp. Ratings shopping and asset complexity: A theory of ratings inflation. *Journal of Monetary Economics*, 56(5):678–695, 2009.

J. Sobel. Signaling games. *Encyclopedia of Complexity and Systems Science*, pages 8125–8139, 2009.

L. J. White. The credit rating agencies. *Journal of Economic Perspectives*, 24(2):211–226, 2010.