Fiscal Discoveries, Stops and Defaults.

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Abstract

1 Introduction

Countries not so long ago heralded as growth success stories of the advanced world such as Ireland and Spain have witnessed, over the past two years, skyrocketing spreads on their sovereign bonds, plummeting confidence in the state of their public finances, and large output drops. Such a turnaround in market assessment of country risk have been all the more dramatic in Greece and Portugal – once again countries deemed mostly advanced and which have been long declared as graduated from "debt intolerance" (Reinhart, Savastano, and Rogoff, 2004). The fact that those four countries are part of a wealthy and systemically important currency union, which also enables them to issue own currency-denominated debt in deep bond markets (and thus being free from the so-called "original sin") and limits policy discretion through a variety of legal arrangements, makes those recent developments all the more striking from a historical perspective.

Prima-facie, five main features of the recent debt crises stand out. First, its common origin – a far-reaching distress in a major financial center (the US) beginning with a string of defaults on tranched mortgage bonds in the summer of 2007 that culminated with the closure of a major investment bank (Lehmann Brothers)

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and seizure of inter-bank money markets across much of the advanced world. As global demand and trade contracted in response to the sharp tightening of credit conditions, so did output, and the eurozone was no exception. As shown in Figure 1, the downturn was quite synchronized. While it did hit harder countries where leverage was unprecedented on the back of inflated real estate valuations like Ireland and Spain, it was nevertheless observed in countries like Germany where borrowing was far more subdued. In fact, as also shown in Figure 1, the downturn was not substantially worse in Germany than that in Greece and Portugal – countries that soon after came to be at the epicenter of the sovereign crisis.

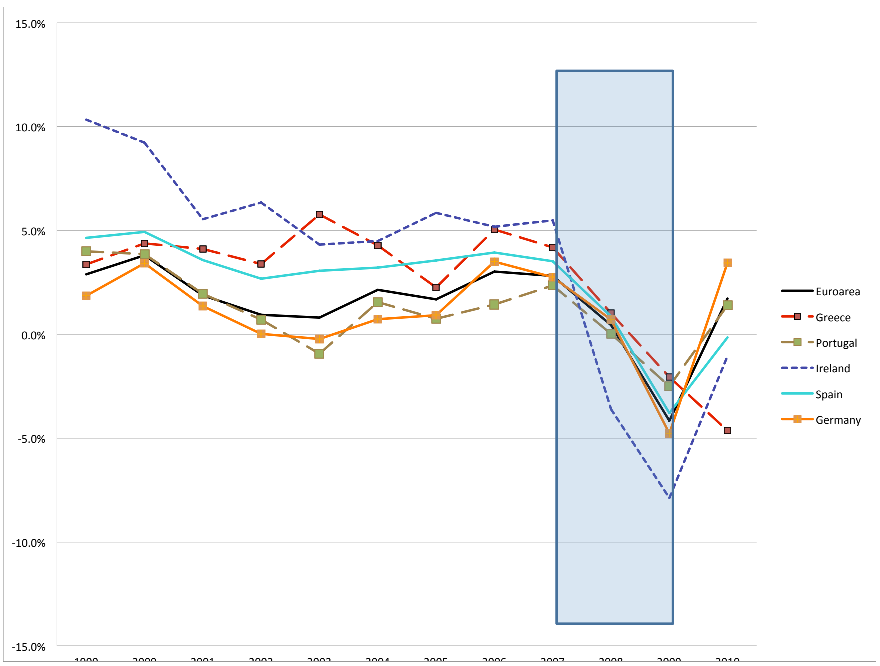

Figure 1: Real GDP growth in the Eurozone.

The second main feature of the crisis is the marked decoupling in eurobond yields from mid-2008 on as shown in Figure 2. That is, while the initial output shock was quite synchronized, and of roughly similar magnitude across the eurozone (Ireland and Spain standing farther apart), bond yields separately markedly, reversing the striking convergence of yields between 1999 and 2007. The discrete nature of such a de-clouping across countries facing a similar shock is suggestive of an important shift between two potentially very distinct equilibria, as we discuss below.

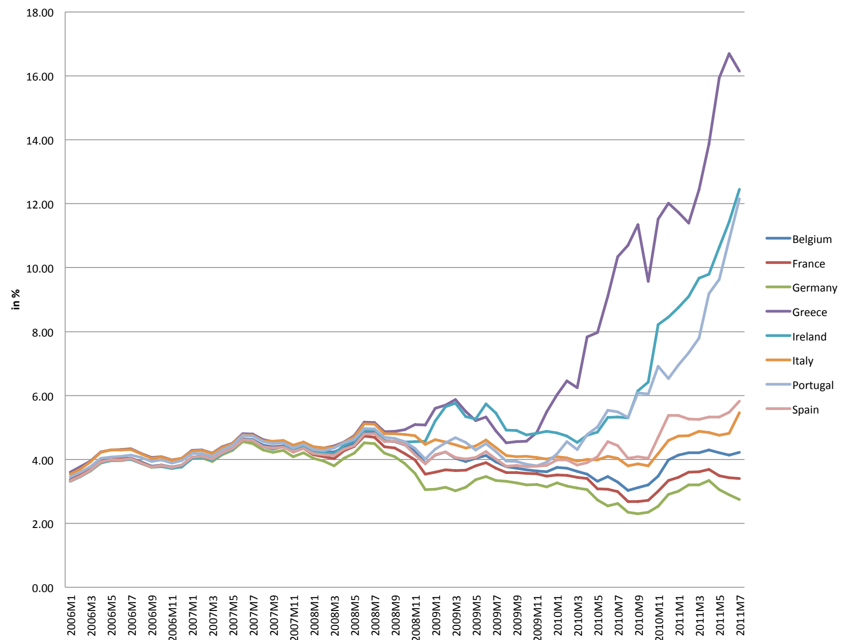

Figure 2: Long Term Interest Rates on Sovereign Debt of Selected Euro Countries.

A third and related feature pertains to the dynamics of national public finances. While large common shocks and squeezing public finances have long been typical ingredients of major financial crises (cf. Kindleberger, 1978; Reinhart and Rogoff, 2010), the magnitude the recent squeeze is off-scale. Yet, arguably no less striking is the fact that, while the output drops have been roughly comparable except for Ireland and Spain (cf. Figure 3), the deterioration of fiscal balances has been far more heterogenous. The behavior of tax revenues is part of the story (cf. Figure 3) but, the decoupling in fiscal peformance can be seen more clearly when one looks at the ratio of government expenditure to revenues in Figures 4 and 5. Compare for instance Greece and Germany. Starting from an initial position where the ratio of government expenditures to revenues were the essentially same in the two countries in 2006, by mid-2009 the same ratio was between 15% to 22% higher in Greece, depending on whether one excludes interest expenses. This was so despite the fact that the drop in the national tax base (i.e. GDP) had been roughly similar (cf. Figure 1). For Ireland and Spain, the deterioration of fiscal balances was even far more dramatic than in Greece, as all three governments did not contain spending in tandem with the decline in tax collections – as other core euro area countries (notably

Germany) did. Thus, the flip side of yield decoupling has been the decoupling in fiscal deficits.

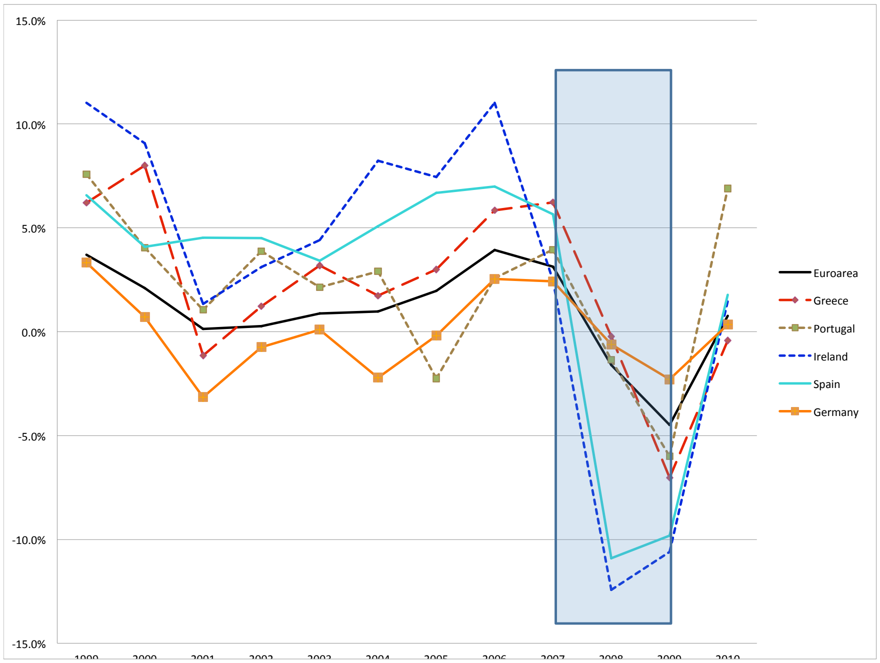

Figure 3: Growth of General Government Revenues (CPI deflated).

A fourth, less measurable and yet arguably no less important feature of the crisis, has been the seemingly pervasive uncertainty on the part of investors about both the actual and the prospective state of national public finances. Such uncertainty has been widely acknowledged in official documents as well as by the general press. One particularly striking illustration comes from an official report by the European commission on the state of Greek government debt and deficit statistics dated of January 2010:

"On 2 and 21 October 2009, the Greek authorities transmitted two different sets of complete Excessive Deficit Procedure (EDP) notification tables to Eurostat, covering the government deficit and debt data for 2005-2008, and a forecast for 2009. In the 21 October notification, the Greek government deficit for 2008 was revised from 5.0% of GDP (the ratio reported by Greece, and published and validated by Eurostat in April 2009) to 7.7% of GDP. At the same time, the Greek authorities also

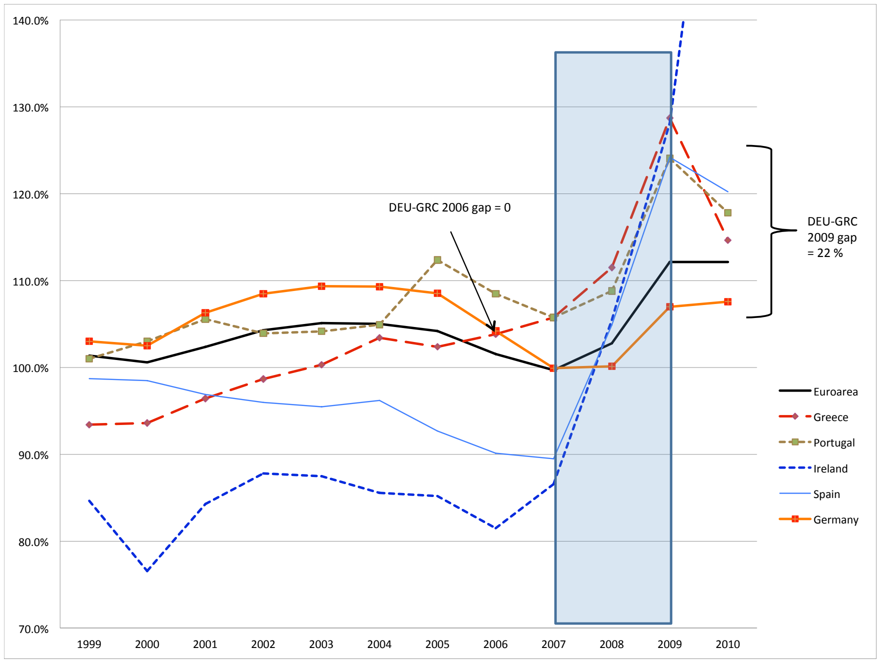

Figure 4: Ratio of General Government Overall Expenditures to Revenues.

revised the planned deficit ratio for 2009 from 3.7% of GDP (the figure reported in spring) to 12.5% of GDP, reflecting a number of factors (the impact of the economic crisis, budgetary slippages in an electoral year and accounting decisions). According to the appropriate regulations and practices, this report deals with estimates of past data only. (...) Revisions of this magnitude in the estimated past government deficit ratios have been extremely rare in other EU Member States, but have taken place for Greece on several occasions."

Further, such information blurring on the actual state of finances seems to have aggravated uncertainty about tax enforcement policies and overall fiscal conduct going forward. As the New York Times reported earlier this year: "tax revenues in Greece fell 5.4 billion short of its budgeted revenues last year through a combination of unpaid taxes and an slowing economy.(...) In fact, tax collection was so poor that the Greek government decided last September to offer an amnesty program, allowing tax payers to settle their outstanding debt by paying just 55% of the bill."[1] Overall, uncertainty on the evolution of public finances has been exacerbated not

[1]New York Times, Feb 21th, 2011, p. A4.

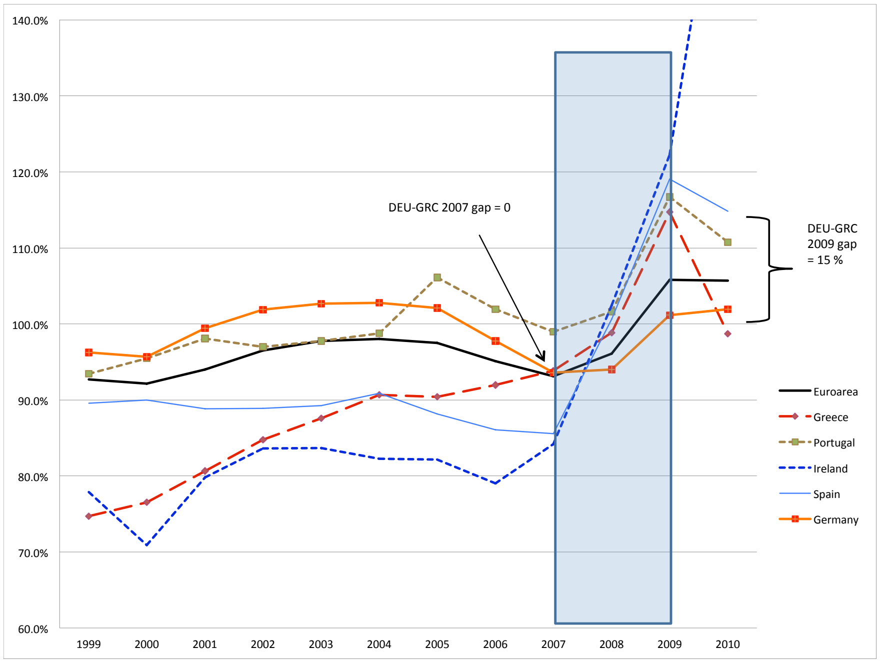

Figure 5: Ratio of General Government Primary Expenditures to Revenues.

only by a spate of major revisions in national budget figures (typically in downward direction), often announced by the respective authorities with substantial lags, but also by hikes in sovereign spreads following such fiscal revelations, raising future debt servicing costs.[2] This seems to be suggestive enough of asymmetric information on the true state of economic fundamentals, since if fully information on the latter were promptly available to investors, it would be immediately arbitraged away, obviating any sharp correction in bond prices upon its public announcement. In short, of non-trivial information asymmetries between government, investors and the general public should arguably be a key ingredient of any model purporting to explain the eurozone debt crisis.

The fifth and perhaps most distinctive feature relative to past emerging market crises, is that countries have been able to tap markets for the most part throughout the turmoil, albeit at a much higher spread. Unlike Mexico in 1994/95 and East Asia

[2]For instance, at the early stages of the crisis on April 22, 2009, when the European Union statistical service (EUROSTAT) announced that Greece's budget deficit in 2008 was revised up by 1% of GDP from the previous official figure of 12.9% (which was itself revised up from a string of previous estimates of under 10%), spreads went by some 60 basis points upon the announcement.

in 1997/98, the stop in net capital inflows and attendant current account reversal were **not** that all that sudden.[3] Even in the Greek case, where fiscal fundamentals are believed to be far weaker than in other EU peers, the government's need for fresh cash were met not only by bond purchases from the European Central Bank and fresh multilateral lending (by the EU and the IMF), but also by concomitant tapping from private capital markets. In contrast with other major debt crisis episodes, like in the 1930s, access to private capital markets was never entirely lost, even if the maturity of new debt is dramatically shortened.[4] In fact, tapping from private capital markets by some of the affected countries (and regions therein) often intensified.[5]

The aim of this paper is to develop a model that can account for these facts. In particular, we study an economy where asymmetric information about the true state of public finances following a bad shock gives rise to fiscal "discoveries" that can bring about a major cross-country decoupling in yields. In particular, our model shows that rapidly rising spreads can take amidst continuing market access following the fiscal revelation. In the model, as also in reality, default is a possible – but not necessarily inevitable – equilibrium outcome of large fiscal shocks.

The postulated mechanism is as follows. A sizable tax revenue shock, which is unobservable to investors but observable to the sovereign government and known to be (likely) very persistent, strikes the country that has a non-trivial net debt to GDP ratio to begin with. To the extent that spending cuts are sufficiently costly, this forces the sovereign to demand fresh cash ahead of the "normal" debt roll-over once

[3]For example, as the crisis continued exacerbate, the Financial Times reported on November 9, 2010 that: "The next test to Athens comes next month as the country needs to refinance EU 480 millions of debt maturing on December 24 (while) Greek 10-year bond spreads have risen to 11.30 percent from 8.77 percent since October 13". In the event, in that very same month, and amidst such a sharp rise in spreads, Athens sold EU390m worth of fresh debt.

[4]This is consistent with other debt crises, where maturity is endogenously shortened only once the crisis is underway (see Detragiache and Spilimbergo, 2006, and Broner, Lorenzoni, and Schmukler, 2010). As discussed below, this is also a feature of our model.

[5]As recent as 31 January 2011, it was reported, for instance, that: "Catalonia, one of the richest parts of Spain, needs to raise 10 bn - 11bn in debt this year to cover deficits and repay earlier loans" Andreu Mas-Colell, finance minister in the newly elected Catalan nationalist government, conceded in an interview with the Financial Times that it was "not a negligible amount", as he added up the numbers and explained how he had inherited unfunded deficits from the previous, Socialist-led regional government. "We're not yet guilty of anything," he said, in an echo of the outraged complaints of Greek ministers in 2009 when they inherited a deficit from their predecessors in power that was much worse than previously announced." The fact that the magnitude of the unfunded deficit is suddenly and massively revised and that it was successfully "hidden" by the previous administration (as shortfall of such a large magnitude does not originate overnight) further corroborates of how pervasive the asymmetry of information can be. The above quotes also illustrate how further market tapping to close the fiscal gap has often been the chosen course of action.

the previously contracted (long-term) debt matures. Under asymmetric information, the incipient market tapping signals to investors that the sovereign has been hit by a large and likely persistent revenue shock. So, even if the tapping is successful and net borrowing goes up, this indicates that debt repayment capacity has been compromised relative to the pre-shock baseline. Hence the future expected ratio of debt to revenue ratio goes up, raising country risk. In response, risk neutral investors raise spreads. By increasing the cost of future repayment and hence lowering the cost of a subsequent default, this increase in spread increases default risk. Default may in fact materialize if the country is hit by a subsequent round of adverse revenue shocks.

In order to make this point clear, we consider two possible games. In the first game, the "Buy-Back game", the country has an option of either issue new debt or buy back old debt in the middle-period after observing the shock. In the second game, the "No-Action game", the country has the option of either stay put (call it a "no-action") or issue new debt in the middle-period upon receiving the shock. Consider first the "Buy-back game". In this case, we show that there are two types of equilibria. First, there is a pooling equilibrium in which the country always issues new debt in the middle-period no matter what the shock realization is. But there is also a separating equilibrium in this game: the country, upon receiving a good revenue shock, would like to buy-back (or retire) existing debt; or, upon receiving a bad shock, to issue new debt. In other words, seeks to smooth revenue shock. Accordingly, a country that receives a good shock would like to buy-back debt and the country with the bad shock will issue. This last type of equilibrium is completely revealing, i.e, the country that issues is revealing that it received a bad shock that will compromise its repayment capacity, will thus face a higher yield. Conversely, the country that buys back debt will see its yield dropping. In other words, investors will differentiate any two countries according to their shocks by seeing one buying back and the other issuing. Hence, in this game, the "good" country is the one "binding", it the one, that under certain conditions wants to separate.

In the"No-Action game" there are also two types of equilibria. In a fully revealing separating equilibrium, the country that receives a good shock will stay put, whereas the country receiving a bad shock will issue. In the pooling equilibrium, regardless of the shock realization the country will stay put. In this game, however, the separating equilibrium is one where the "bad type" wants to separate: the good type stays put under the common shock, whereas the bad type goes to the market to issue new debt.

As we illustrate with numerical calibrations, whether a pooling or a separating equilibrium prevails will depend on some key deep parameters. These parameters include the size of the shock, its persistence, the underlying discount rate, and the country's credibly pleadegable collateral - broadly modeled as inversely proportional to the typical hair-cut and output losses that lenders suffer once the borrower defaults. In general, we find that separating equilibria dominate when the variance and persistence of the underlying stochastic process for shocks are large enough, the country has a lower pleadegable collateral, and/or a higher discount rate.

Consider first the "Buy-back game". In this case, when a country (call it DE) is hit by a good shock, it goes to the market to retire existing debt, instead of further bolstering spending plans. But by so doing it separates from the bad shock country (call it GR) which typically prefers to pool - i.e. always go the market. Once investors see such a differential behavior in market access, the respective yields will move apart. When shocks are sufficiently small, all countries pool, so yields converge. But not once one large shock hits the countries differentially.

A different interpretation arises in the'No-Action game". In this case, the good country (identified on the basis of its deep parameters) may simply stay put under a good or bad shock. Suppose, in this case, that DE and GR receive an equally bad shock. Since more often DE will want to pool in the non-action case, it will not go to the market to issue new debt. In contrast, GR – because of its deep parameters – will be more prone to be on a separating equilibrium. So, it will separate under the bad shock by going to the market and hence will face a higher spread. As in the previous game, yields will move apart. In this case, where both countries faced the same bad common shock, DE's strategy of not tapping the market is easily rationalizable if the shock is common to all countries: if the shock is common to all countries, there is no scope for international risk sharing, so the country has to adjust to the shock by cutting spending (or else to default). While both games display equilibria that can rationalize observed yield decoupling, we discuss how these two possible games and alternative actions therein fit the stylized facts described above.

In addition to rationalizing yield decoupling, the model is also capable to account for some other stylized facts of debt crises which we document in section 2 of the paper. One is the possibly quite distinct relationships between "stops" in capital inflows and default in sovereign bonds. This becomes clearer once one defines - as arguably one should - a “sudden stop” as an abrupt inward shift in the lending supply schedule faced by any given country. In this case, the “sudden stop” can materialize in terms of either prices (spread shifts), quantities (variations in gross and/or net borrowing), or a combination of both. In the model’s separating equilibrium, sudden stops typically precceed sovereign defaults: once the sovereign is hit by a bad fiscal shock leading to higher demand for borrowing, a stop materializes through prices only; spreads go up but there is actually an increase in fresh borrowing. So net external debt goes up and the current account remains in deficit. So, the quantity flow alone will be a very misleading indicator of a SS. This is clearly observed in the recent debt crisis.

Conversely, in a pooling equilibrium with non-action, the country faced with a bad tax shock will not experienced a sudden stop. Again, this is because there will not be a negative revision of country risk by investors, and so there is no bond repricing and hence no SS. Yet, because reality eventually bites, the probability of default following the adverse shock may be higher due to shock persistence; to the extent that large fiscal shocks can be very persistent, a default may materialize if sufficiently large new adverse shocks come along the way. In this “pooling” equilibrium case, a possible eventual default will not be preceded by a SS. But it may if subsequent shocks are sufficiently negative. In short, the model encompasses cases in which a default is preceded by a stop or not. These different relationships between sudden (or not so sudden) stops and sovereign defaults seem more in line with the varied pattern of these relationships in practice, as buttressed by existing historical data.

In nesting possible equilibria where a SS and a SD both take place, this paper relates to two main strands of the literature. One major strand is the work on sudden stops in capital flows pioneered by Calvo (1998) and further developed, both theoretically and empirically, by Caballero and Krishnamurty (2001), Calvo, Izquierdo and Mejia (2004), Calvo, Izquierdo and Talvi (2006), Kehoe et al (2005), Mendoza (2006, 2009). Much like in Calvo (1998), there is an association between output drops and SSs in our model. In Calvo (1998), the SSs arises from an un-antecipated shock to relative prices that drives the unhedged domestic producer with a short foreign currency position insolvent. As this makes her unable to borrow and produce further, an output drop immediately follows. In contrast, in our model there is no relative price shock and unhedged currency positions (due for instance externalities that lead to the underpricing of risk as in Caballero and Krishnamurty) leading to the SS and the subsequent output collapse. In fact, in the separating equilibrium case, the causality is as suggested by Kehoe et al (2005): a bad shock leads to the SS. But since there is also a pooling equilibrium, this will not be necessarily so in all cases as mentioned above. More broadly, information asymmetries are not present in these previous contributions and SSs are gauged as quantity shocks. In contrast, the SS in our model often manifest first and foremost through price adjustments (shifts in spreads). Once SSs are defined as inward shifts in the investors' loan supply curve, whether price or output effects dominate will depend on what happens to sovereign demand and ancillary model parameters. Finally, it is important to notice that the mechanism we focus on is not incompatible with financial friction models of SSs, but rather complementary. In our model, output and tax revenue volatility are exogenously given, as is their persistences, and these may result from the combination of financial frictions and the menu of shocks (such as to the world interest rate) analyzed in previous models (e.g. Perri and Neumeyer, 2005; Mendoza, 2009). In neither of these models, however, is there default in equilibrium.

In allowing for default as a possible equilibrium outcome, our model is also closely related to a rich literature on sovereign risk. As in Aguiar and Gopinath (2006), Arellano (2008), our model builds on the volatility and persistence of output shocks (in our case translating into tax revenue shocks) as drivers of fluctuations in country risk. Aguiar and Gopinath (2006) find that greater output persistence tends to raise sovereign default risk in a model with complete symmetry of information between borrowers and lenders, where default is punished by market exclusion, with exogenous re-entry probability rather than an endogenous effect through prices. A key prediction of their model is that countries with higher underlying persistence of output shocks are more prone to default. In a model also featuring symmetric information and full market exclusion as punishment device, Arellano (2008) shows that higher output volatility raises sovereign spreads. Yet, by virtue of the symmetric information assumption, none of these models can explain sharp hikes in spreads upon fiscal news announcements, nor why country risk can fluctuate as sharply under continuous market access. Allowing for the presence of information asymmetries between borrowers and lenders buys us precisely the capacity to explain these phenomena in a way that is consistent with the stylized facts mentioned above. In this regard, o, ur setting is more closely Eaton (1996), Alfaro and Kanuzck (2005), Sandlieris (2008), and Catao, Fostel, and Kapur (2009) in that information asymmetries associated with investors's uncertainty about either the country's type or the persistence of output shocks are a key determinant of fluctuations in sovereign spreads. In these papers, as well as ours, investors learn from the country's action, updating their beliefs about future fundamentals along the way which are then reflected in the re-pricing of sovereign bonds. The main departure of our setting relative to these latter contributions is to highlight the role of fiscal shocks and market tapping mechanism as a signaling device. Also unlike these previous studies, our model thus allows for the possibility of a pooling equilibria where the country successfully does not reveal the true state of fiscal fundamentals: investors either never learn about them or only do so much later, when outright default materializes.

The plan of the paper is as follows. Section 2 below reviews the empirical evidence on debt crises, highlighting some key similarities between recent and past episodes, which corroborate as well as offer some further insights into the stylized facts about the eurozone debt crisis discussed above. Section 3 lays out the model and its predictions on the relationships between SSs and SDs under the distinct equilibria - pooling and separating. Section 4 presents the respective simulations results. Section 5 concludes. Specifics of the proofs and the data are provided in Appendices 1 and 2 respectively.

2 Stylized Facts

In this section, we broaden the set of stylized facts discussed above, zooming in on the dynamics of bond prices (spreads), external borrowing, and fiscal balances not just in recent eurozone crisis but also in other debt crises as well. The aim is to compare the external financing aspects of recent eurozone crisis with those of other crisis episodes – both recent and long past – and, in so doing, try to better demarcate the set of "stylized facts" that our model of the crisis transmission mechanism provided in section 3 seeks to rationalize. Four questions are addressed in this section:

1. Are crises typically preceded by both rising spreads and net foreign borrowing? Or do net inflows and spreads move in opposite directions (borrowing down, spreads up)?
2. How "sudden" are stops in net borrowing and do they typically precceed or follow default announcements?
3. How do spreads and net borrowing typically correlated with fiscal positions?
4. In particular, are defaults preceded by seemingly greater uncertainty on fiscal outlooks and indicative evidence of asymmetric information between investors and the sovereign regarding fiscal developments?

We examine these questions in the context of a comprehensive cross-country database on sovereign spreads, external borrowing, as well as on general government debt, spending and tax revenues spanning the period 1970-2010. While some of this historical data is now readily available thanks to recent seminal work on the anatomy of debt crises (see Reinhart and Rogoff, 2009 and references therein), a main contribution of our data work is its extended sample on fiscal indicators (comprising general - rather than just central – government debt) and the fleshing out their relationship to external bond prices and debt liabilities, using an updated version of Lane-Milesi-Ferretti (2007) dataset. We would argue that this extended and updated cross-country sample allows a more systematic description of inter-play of these variables than we have been able to find in previous work.

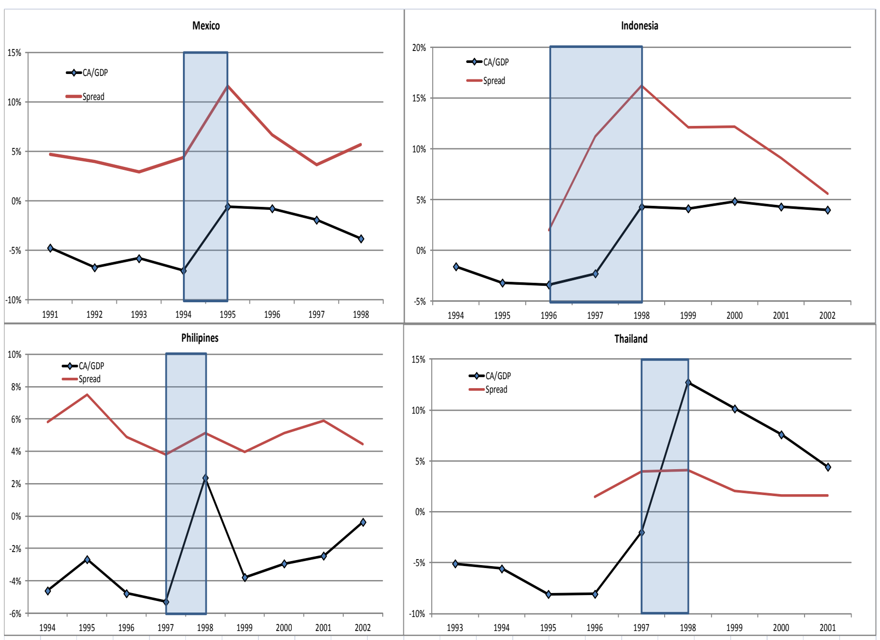

Figure 6: Mexican and Asian Debt Crises: Net External Borrowing and Sovereign Spreads.

Starting with question 1, existing models of sudden stops in capital flows take the Mexican and Asian debt crisis of the 1990s as the paradigmatic set of facts they purport to explain (see Calvo, Izquierdo, and Mejia, 2008 and the many references therein). So, we first review those events and ask how far they are indeed paradigmatic cases vis-a-vis other SS/debt crisis experiences, such as those in continental Europe over the past three years.

Figure 6 plots the dynamics of sovereign spreads and of the current account for Mexico as well as selected Asian countries in the run-up to the respectiv debt crises.[6] In the four-year window precceeding the crisis, spreads were about flat (in fact dropping some in 1993) while external borrowing rose markedly, as indicated by persistent current account deficits in excess of 5% of GDP. Indeed, while spreads rose in the first half of 1994 in the wake of electoral tensions (culminating with the assasination of presidential candidate Colossio in April 2004), they came down soon after and in the month before the December 1994 crisis spreads were virtually back to the 1991/92 average at around 400 bps. Spreads only shot up upon the announcement of the peso devaluation and mounting concerns over the servicing of domestic debt obligations ("Tesobonos"). This was immediately followed by the sudden current account reversal and the associated collapse of net borrowing, all in a matter of months. Thus, the sudden stop in both quantities (net external borrowing) and prices (spreads) was roughly concomitant, with the two variables moving in sharply opposite directions from the first quarter of 1995. A broadly similar pattern is observed during the Asian crisis, albeit with some notable differences, like the more longer build-up in Indonesia and a more subdued hike in spreads in the Philipines (helped by large IMF disbursements close to 200% quota in 1997 and 1998).

Such a pattern of an abrupt and sharply negative correlation between spreads and net borrowing does not, however, quite fit recent developments in Europe. In contrast with the 1990s EM crises, Figure 7 shows that Greece's current account remained highly negative throughout 2008-2010; despite a 3 percentage point narrowing in 2009, the current account deficit remained very large and close to the pre-2008 average of 10-11% of GDP. Unlike Mexico, therefore, market access did not come to a full standstill. Rather, the build-up to a full fledge crisis has been more gradual: net external debt continued to rise, reaching 105% of GDP by end-2010, while spreads continued to climb up. While debt repurchases by the European central bank (ECB) did facilitate, not only did the ECB repurchase program start relatively late in the crisis timeline (May 2010), but also some private capital market access (through strategically timed bond auctions) was preserved. So, unlike Mexico and

[6]We omit the data for Korea and Malaysia in these comparisons due to the lack of a consistent series sovereign spreads before the 1997 crisis. Evidence on bond price developments for these two countries from 1997 is available from IMF, 1998, International Capital Market Developments, Prospects, and Key Policy Issues.

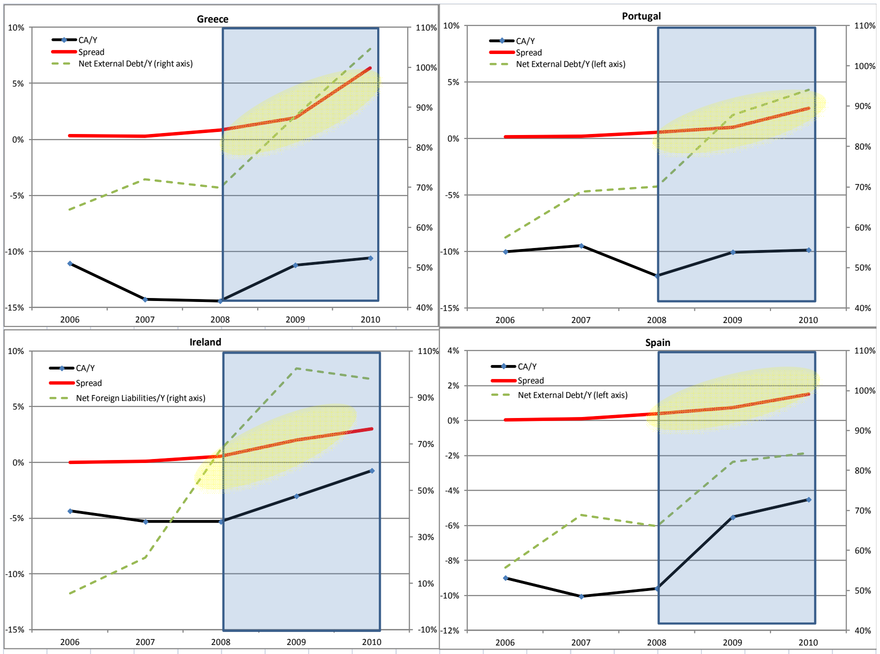

Figure 7: European Debt Crisis: Net External Borrowing and Sovereign Spreads.

Asia, would overlook the crisis build-up by merely focusing on net borrowing flows. A similar story holds for Portugal. In the case of Ireland and Spain, the current account does narrow dramatically as the crisis worsened in 2010; yet, in the Spanish case it still remained substantially negative through 2010, with net external debt continuing to mount. In all four European crisis countries prices and quantities have moved in the same direction throughout, in contrast with the Mexican experience.

This comparison between the paradigmatic Mexican crisis vs. post-2007 Europe does not, however, answer the question of which of these two experiences is more the norm than the exception. To answer this question, we look at a broader cross-country sample of debt crises since 1970. We define a debt crisis as episodes of either an outright default or a near-default, where the latter is defined as a combination of a major drop in bond prices (larger than 2 standard deviations) and a large multi-lateral financial support. In the case of IMF support (such as during the Argentine and Mexican crises of 1995, as well as the Asian crises of 1997-98), the definition of "large" support is that of at least twice as large as the respective country's quota in the IMF, when all net disbursements are computed from program's inception to end. The definition of outright default is that of Calomiris and Beim (2001) updated with information from the Standard & Poor reports compiled in Borensztein and Panizza (2008) and widely used in the literature on sovereign defaults. Because the crsis mechanisms examined in this paper require some reasonable degree of country integration with international capital markets, our sample comprises emerging markets and advance countries, excluding countries where most borrowing through the sample period has been on concessional/multilateral basis. The resulting sample of events by country/year is reported in Appendix 2. We report below the cross-country means or medians (when outliers entail a noticeable discrepancy between the two measures) of these various country/year events, centered within a eight-year window.

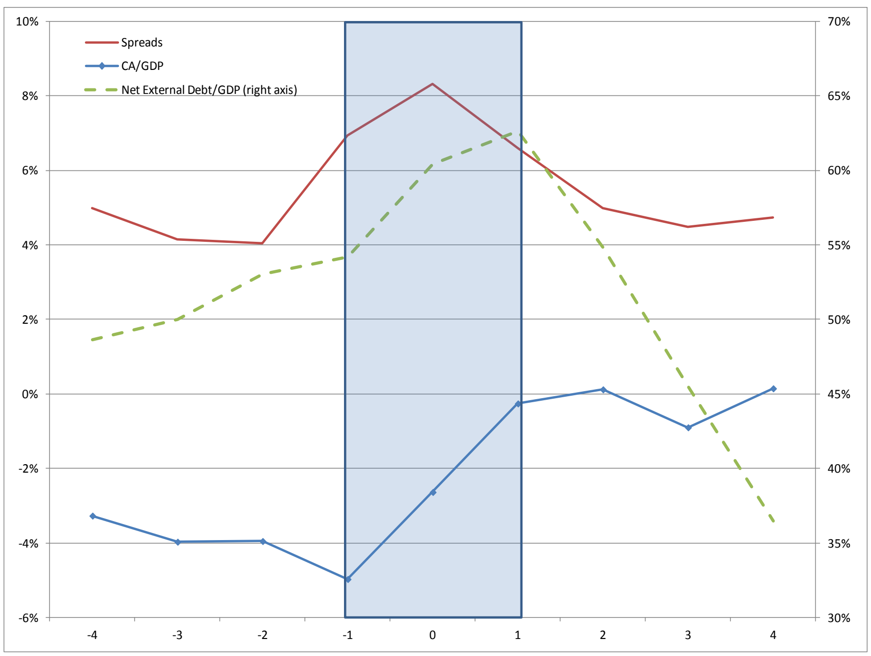

Figure 8: Other Debt Crises: Net External Borrowing and Sovereign Spreads.

Figure 8 depicts the cross-country mean of net foreign borrowing (comprising both debt and equity instruments) in countries of the Appendix 2 sample excluding the Mexican, Asian and european crisis countries, and for which data on spreads were available throughout.[7] As standard, net foreign borrowing is scaled by the

[7]Even though we were able to compile some spread data for a few countries from the late 1970s, the overwhelming majority of spread data covers the 1992-2009 period, so this was the binding

respective countries' GDP. There is no SS in net borrowing prior to the default (or multilateral bail-out) event at t=0. Debt crises are typically associated with continuous fresh borrowing all the way through the eve of defaults. Thus, there is not SS in quantities preceding the year of actual default (of full-fledge bail-out). That, if anything, takes place only upon or immediately after the default. Figure 8 also shows that the positive connection between rising borrowing costs and external borrowing in the run-up to defaults and "near defaults" is also observed in pre-2008 debt crises. Far from staying about flat in the run-up to the crises and then spiking up and down, there is a sustained rise of spreads and then a gradual decline to pre-crisis levels. In other words, as discussed below, while fiscal fundamentals deteriorate and borrowing needs go up, so does actual borrowing and, with it, borrowing costs. The stop and attendant current account reversal is noticeably less "sudden" than in 1995 Mexico and 1997 Asia.

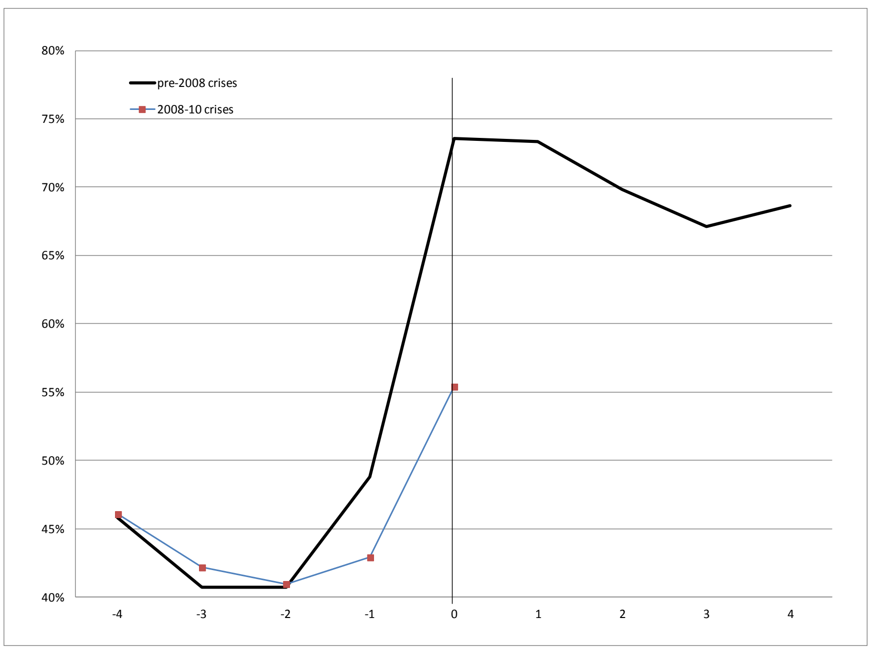

Figure 9: All Debt Crises: Gross General Government Debt.

constrain to the sub-sample selection. This crisis sub-sample includes: Argentina (2001), Brazil (1983, 1999), Bulgaria (2009), Cote D'Ivoire (2000), Dominican Republic (2003, 2009), Ecuador (1999, 2008), Hungary (2008), Nigeria (2002), Pakistan (1998), Turkey (1999, 2008), Ukraine (2009) and Uruguay (2003).

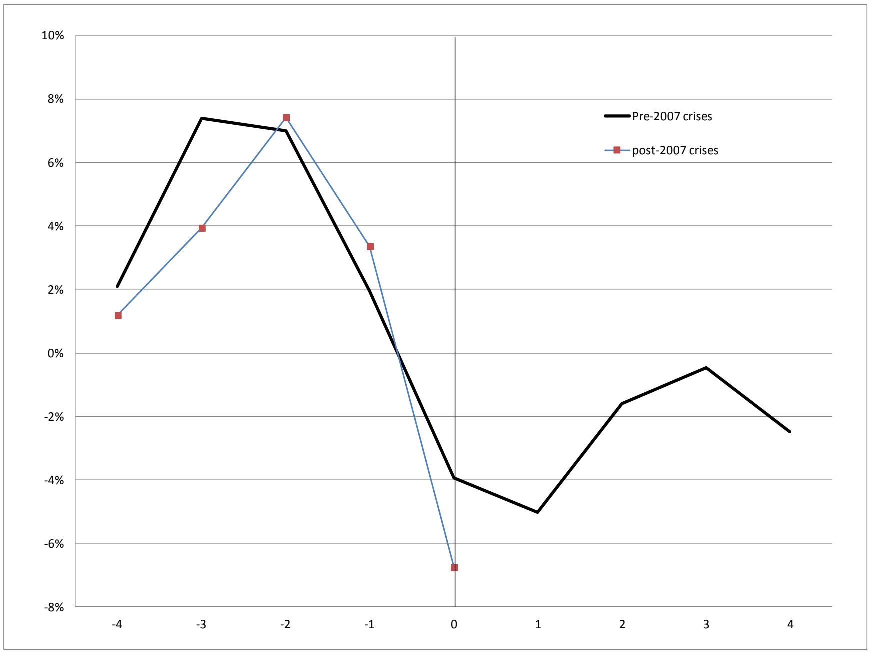

Figure 10: All Debt Crises: Average Real Tax Revenues.

Figures 9 to 11 provide evidence on the role of fiscal developments on the ”representative” debt crisis. To make it clearer that the respective averages are not dominated by the post-2007 sub-sample, we present the pre- and post-2007 averages in separate lines. Both cross-country averages shown in Figure – and now taken over the full appendix 2 sample since, unlike spreads, debt data is available throughout – show that rising spreads have also been associated with increasing gross borrowing by the **general** government, which includes not only external but also domestic debt.[8] This data – which excludes private borrowing flows – clearly indicates that fiscal developments have been key to the anatomy of most external debt crises. In this regard too, a main contrast between the paradigmatic Mexican and Asian experiences (where actual fiscal deficits and public debt build-ups have been on average much lower) is that the “representative” debt crisis is typically precceeded by a substantive deterioration of fiscal positions.

[8]We focus on gross rather than net government debt for two reasons. One is that the gross series is an alternative indicator of the public sector demand for funds from capital markets (rather than a rise in net debt which could be met with sales of government assets). Second, data on net debt are not readily available for most countries in our sample.

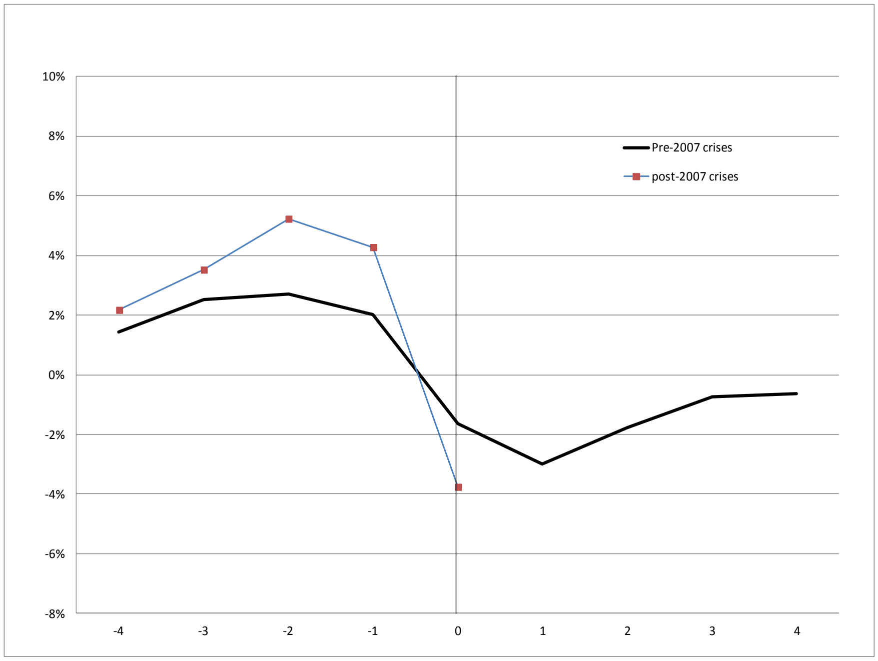

Figure 11: All Debt Crises: Real GDP.

This in turn begs the question of what is behind such fiscal deterioration the associated rise in governments' financing needs. Figure 6 highlights a key driver: the downturn in real fiscal revenues (nominal revenues deflated by the respective country's CPI), all measured relative to (an HP-filtered) trend. In both pre- and post-2007 the drop is spectacular and in fact of a somewhat similar magnitude – with some apparent difference regarding the onset of the drop, with pre-2007 crisis being marked by a slightly more protracted tax revenue slowdown, but this is largely due to having set 2009 as the peak crisis year for some of peripheral Europe (i.e., if we had set t0=2010 in these cases, the tax revenue slowdown would have started earlier). While this deterioration in real tax revenues results from a concomitant slowdown and eventual collapse of the tax base as indicated by a widening of the output gap, the amplitude of the former is far larger than that of output relative to trend (cf. Figure 11).[9] This indicates that part of the revenue shortage relative to

[9]This pattern of output slowdown in the run-up to defaults is consistent with many empirical studies of sovereign debt crises (see, e.g., Levy-Yeati and Pannizza, 2009; Reinhart and Rogoff, 2010; and references therein). Yet, there is at least one study (Wright and Tomz, 2009) which looks at data sample begining in 1820 and argues that a non-trivial (but still far from overwhelming) fraction of defaults take place during "good times." We find no evidence of that in our post-1970

its trend is also due to a tax collection slowdown beyond what is warranted by the GDP drop, and this has been clearly the case in the ongoing European debt crises.

Finally, and turning to question 4 of the above check list, the other key ingredient of the ongoing sovereign debt crisis has been the role of fiscal uncertainty. An arguably important indicator of fiscal uncertainty is the extent to which the fiscal outlook changes with current fiscal news and the market react to such news. This has been particularly dramatic in the Greek case. Data revisions on the magnitude of the fiscal hole have been very large upon each successive announcement, leading to substantial revisions – by both market participants and official agencies – to the medium-term forecasts of output growth and fiscal outurns. This is illustrated in Figure 12 which plots IMF forecasts for general government debt. The figure shows that the October 2007 forecast of D/Y for the medium-term was 70%; a year later, that rose to 82% and then to a 110% of GDP six months later. By April 2011 (last available data by the time of writing), this forecast had jumped even further to 157%. Sudden revisions of this magnitude are not only rare but also substantially above than that for euro area countries that also experienced a severe recession and unexpected deterioration of their fiscal outlooks. In the United States, the epicenter of the crisis, the 2012 debt to GDP forecast initially jumped from 65% in October 2007 for 103% of GDP in April 2009, but then basically flattened – ie. subsequent forecast revisions have been trivial. In the case of Greece, the same April 2009 IMF forecast exercise – based on the latest available figures provided by the Greek authorities at the time – envisaged D/Y in 2012 as 110% of GDP; then to 141% barely a year later and then to 158% of GDP in the April 2011 forecast round.

This is indicative of substantial uncertainty regarding fiscal developments. Large sudden revisions that fueled this uncertainty can arise from either new shocks or previous mis-measurement of public expenditures and revenues; so it is not per se indicative of asymmetric information between the government and investors. However, two pieces of evidence are consistent with asymmetric information. One is the incentive for the government to reveal fiscal "bad news" gradually: the government saves the area between the debt repricing upon announcements. Such staggering of fiscal bad news has been a hallmark of the Greek debt crisis.[10] Second, spreads did jump upon the public announcements of the news, indicating that the government

sample.

[10]This is analogous to the situation of the large trader which can either place a large order to sell or buy an asset at once, or can do so gradually. The latter yields a gain roughly proportional to half of the price difference between the trading dates and the period in between them.

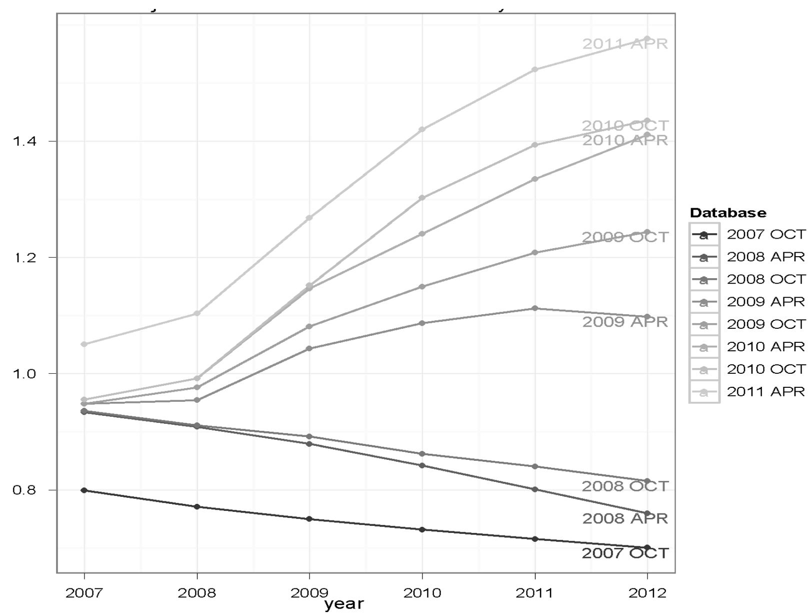

Figure 12: IMF forecasts for Greece.

had some information monopoly on the information, at least for a short while. For instance, on April 22, 2009, upon the announcement by the Eurostat of a full percentage point in Greek government deficit relative to a previous estimate by the Greek government earlier on, spreads on Greek bond jumped to 565 basis points over the German Bund. Most suggestively, an European commission report on Greek debt, dated of August 2010, notes: "Revisions of this magnitude in the estimated past government deficit ratios have been extremely rare in other EU Member States, but have taken place for Greece on several occasions."

As discussed below, this body of evidence is consistent with the crisis transmission mechanism we model: a country is first hit by a bad tax shock which, given sufficiently rigid expenditure needs, leads to a deterioration in the respective fiscal position; to the extent that there is market uncertainty about the overall fiscal outlook and the possibility of obfuscation by the sovereign, once the country taps the market to smooth the revenue shock, market participants read this as true indication of "bad news". Hence, as the country taps the market and external debt rises, so do country spreads. So, much of the adjustment to the new outlook occurs via bond prices rather than quantities. Yet, as also discussed below, this is one of the possible equilibria that may materialize in practice; so an important contribution of the subsequent analysis is also to map a proximate set of parameters in which such an equilibrium is more likely to prevail.

3 Model

3.1 Fiscal Shocks and Sovereign Debt.

A government issues bonds in international capital markets to finance investment in a long-term project which can be related to physical infrastructure and/or human capital development. We develop our argument in the simplest setting, which involves three periods, $t = 0, 1$, and 2. The project's investment requirement in period 0 (which we consider exogenous) generates fiscal revenues τ_0, τ_1 and τ_2 in periods $0, 1$ and 2 respectively.

To finance this requirement at time 0, the sovereign issues long-term debt to be paid in period 2. It issues $D_0 = \tau_0$ at time $t = 0$, it pays interest $r_0\tau_0$ in $t = 1$ and it promises to pay $(1 + r_0)\tau_0$ at maturity in $t = 2$.

In period $t = 1$ government's fiscal revenue τ_1 is subject to a shock $\tilde{\epsilon_1}$ which assumes two values: $\epsilon_1^H = \alpha\tau_1$ and $\epsilon_1^L = -\alpha\tau_1$, with probability p and $1 - p$ respectively, where $\alpha < 1$. A key assumption throughout the model is that this shock is persistent, so that $\rho\epsilon_1$ still affects the fiscal revenues in period 2, τ_2, where $\rho < 1$ is the persistence parameter.

Upon receiving the fiscal shock in the middle period, the borrower has two options:

1. "Buy Back" (B).

   In this case the borrower can buy back its debt paying interest plus principal, $(1+r_0)\tau_0$, at $t = 1$ and re-issue one-period debt $D_1 = \tau_0$ at $t = 1$ which promises $(1+r_1^B)\tau_0$ at $t = 2$. Notice that total outstanding debt at the end of the middle period is τ_0. Hence, after buying back the total outstanding debt at $t = 1$ is the same as in $t = 0$. Another way of interpreting this "buy back" option is that we have in mind a "callable" bond. Although no (or very few countries) issue bonds with a "callable clause", sovereigns (even if legally forbidden to buy-back) may use other agents to do so (paying say a trivial commission), and hence, effectively the bond becomes callable.

2. "Fresh Issuance" (I).

   In this case the borrower can issue new fresh one-period debt D_1 to cover potential fiscal downfalls. It issues $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$. Notice that in this case total outstanding debt at the end of the middle period is larger than the stock of debt at time 0. The stock of debt at time 1 is $\alpha\tau_1 + \tau_0$ compared to the stock of debt at time 0, τ_0.

Finally, the government's fiscal revenues at time 2 are subject to a shock $\tilde{\epsilon_2}$ which can assume two values, ϵ_2^H or ϵ_2^L with probability q and $1 - q$ respectively. Upon the realization of the shock, the government decides whether to pay or default in all outstanding debt. Notice that we are making two assumptions: First, we assume that all debt has the same seniority. Once a country defaults, it defaults in all its debt. Second, we assume that default only happens at the end, this is, there is no default on interest payments in the middle period.[11]

3.2 Lenders and Cost of Default.

The bond market is competitive, with risk-neutral lenders who are willing to subscribe to bonds at any price that, given their beliefs, allow them to break-even. For modeling simplicity we treat the mass of lenders at every period as a single lender.

Lenders have access to a risk-free technology in every period, which pays a riskless interest rate r_f, which in the model is taken as exogenous (and constant across time). There are two debt markets, a long-term debt market at $t = 0$ and a short-term debt market at $t = 1$. We treat creditors at $t = 0$ as different from creditors at $t = 1$.

[11] The first assumption is for simplification sake. Adding seniority would unnecessarily complicate the model without adding any insight on the issue at hand. The second assumption, is without loss of generality, since it will not change (qualitatively) the results in the model, but it is also a very easy assumption to justify. For example, suppose $r = 5\%$ and $\tau_0 = 100\%$, this means that repayment of interest would amount only to 5% of revenues. Clearly, this payment would be easily met given that a very bad shock still leaves you with 40 or 50% of revenues, ie. an amount 10 times higher than what you need to pay.

There is a punishment technology in the model that consists of haircuts and fiscal confiscation. More precisely, in the case of default, creditors receive $c(1+dr)D$, where D is the debt issued, so it could be either τ_0 or $\alpha\tau_1$. This parametrization allows us to consider two extreme situations. In the case in which $d = 1$, the haircut is calculated over both, interest and principal. However, in the case in which $d = 0$, haircut is calculated over principal alone. Moreover, as in any finite-horizon framework, in the absence of other penalties in the final period the borrower would default with probability one. To avoid the trivialities associated with this case, we assume that default in the final period is punished with sanctions that cause the sovereign to lose a fraction η of its current fiscal revenues per unit of face value. A proportion f of this fix cost goes to creditors at time 0, whereas $1 - f$ goes to creditors at time 1. More specifically, in the Buy-Back case, $f^B = 0$ and $1 - f^B = 1$, i.e, a total of η goes to creditors at time 1. On the other hand, in the Fresh Issuance case, a proportion $f^I = \frac{1}{1+\alpha}$ of η goes to creditors at time 0, and $(1 - f^I)\eta = \frac{\alpha}{1+\alpha}\eta$ goes to creditors at time 1. Hence, in this case there is debt dilution in equilibrium.

Now we are ready to characterize lender's cash flows. Figure 13 shows the cash flow associated to lending at $t = 0$. With probability π the debt gets bought back in period 1. In this case, the principal plus interest gets re-invested in the risk-free technology, which in turns yield $(1+r_0)\tau_0(1+r_f)$ at time 2. With probability $(1-\pi)$, the lender receives interest payment in period 1, which are re-invested in the risk free technology. In period 2, with probability $1 - \pi'$ the creditor is paid back interest plus principal, which gives a total revenue of $(1 + r_f)r_0\tau_0 + (1 + r_0)\tau_0$. On the other hand, with probability π' the creditor faces sovereign default in which case he receives $(1 + r_f)r_0\tau_0 + c(1 + r_0)\tau_0 + f^I\eta F_2$, where F_2 is defined as fiscal revenues in period 2.

Figure 14 shows the cash flows associated to lending at $t = 1$. Panel (a) shows cash flows after Buy Back (B). In period 2, with probability $1-\pi^B$ the creditor is paid back interest plus principal, $(1+r_1^B)\tau_0$. On the other hand, with probability π^B the creditor faces sovereign default and in which case she receives $c(1+r_1^B)\tau_0+(1-f^B)\eta F_2$. Panel (b) shows cash flows after Fresh Issuance (I). In period 2, with probability $1 - \pi^I$ the creditor is paid back interest plus principal, $(1 + r_1^I)\alpha\tau_1$. On the other hand, with probability π^I the creditor faces sovereign default, in which case she receives $c(1 + r_1^I)\alpha\tau_1 + (1 - f^I)\eta F_2$.

Finally, notice that r_1^B and r_1^I may or may not be the same. We will discuss extensively this issue at the end of this section.

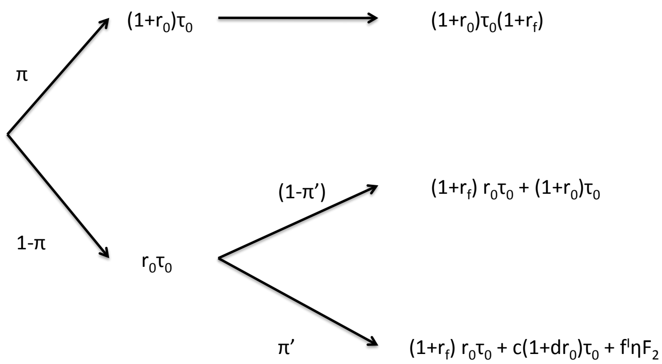

Figure 13: Lending at $t = 0$.

3.3 Sovereign Payoffs.

The government maximizes social welfare. Without getting into the details of a particular social welfare function, we will assume that the government is risk neutral, have a discount factor of β and maximizes expenditure $G = \sum_t \beta^t G_t$. The payoffs in each period are described below.

In period $t = 0$:

$$G_0 = \tau_0 \tag{1}$$

In period $t = 1$ there are two possibilities. If the borrower buys back its debt, we have that

$$G_1 = F_1 - (1 + r_0)\tau_0 + \tau_0 \tag{2}$$

so, expenditures equals fiscal revenues at time 1, $F_1 = \tau_1 + \tilde{\epsilon_1}$, minus debt buy back plus new debt issuance.

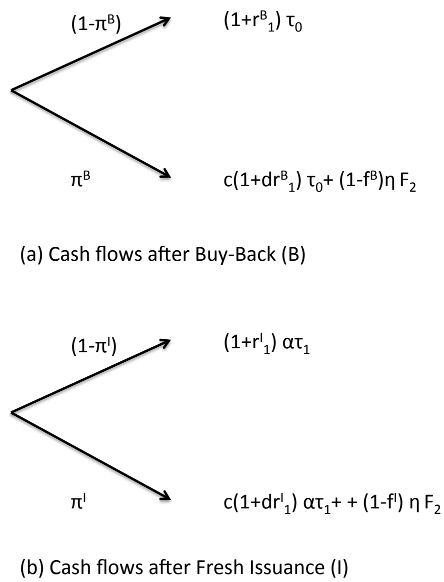

Figure 14: Lending at $t = 1$ to borrowers after (a) Buy-Back and (b) Fresh Issuance.

In case the borrower issues new fresh debt (I), we have that

$$G_1 = F_1 - r_0\tau_0 + \alpha\tau_1 \tag{3}$$

so, expenditures equals fiscal revenues at time 1, $F_1 = \tau_1 + \tilde{\epsilon_1}$, minus interest payments plus new debt issuance.

In the last period there are four possibilities. After buying back the sovereign can repay or default. If it repays, we have that

$$G_2 = F_2 - (1 + r_1^B)\tau_0 \tag{4}$$

hence, expenditure equals fiscal revenues at time 2, $F_2 = \tau_2 + \rho\epsilon_1 + \tilde{\epsilon_2}$, minus debt re-payments.

If it defaults

$$G_2 = F_2 - c(1 + dr_1^B)\tau_0 - \eta(\tau_2 + \rho\epsilon_1 + \tilde{\epsilon_2}) \tag{5}$$

expenditure equals fiscal revenues at time 2 minus default punishment due to default, given by remaining debt obligations after haircuts and fiscal confiscations.

On the other hand, after new debt issuance (I), if the sovereign repays

$$G_2 = F_2 - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1 \tag{6}$$

so, expenditure equals fiscal revenues at time 2 $F_2 = \tau_2 + \rho\epsilon_1 + \tilde{\epsilon_2}$ minus debt re-payments of debt issued at $t = 0$ and $t = 1$.

If it defaults

$$G_2 = F_2 - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 - \eta(\tau_2 + \rho\epsilon_1 + \tilde{\epsilon_2}) \tag{7}$$

expenditure equals fiscal revenues minus punishments due to default on all debt.

3.4 Asymmetric Information

We assume that there is asymmetric information between the sovereign borrower and investors. While the borrower can perfectly observe the realization of the middle period shock $\tilde{\epsilon_1}$, lenders cannot.

The only way lenders can infer some information about the realization of the shock is through the borrower's action in the middle period. This is, lenders will infer information about the fiscal shock at time 1 after observing the sovereign action: Buy-Back (B) or Fresh Issue (I).

Lenders at $t = 1$, after observing the borrower action will update their beliefs of future default and re-price debt accordingly. In the next section we show that in equilibrium two things can happen. There will be situations in which borrowers actions are highly informative and hence the interest rate charged at time 1 is sensitive to the borrower's action. This is, $r_1^I \neq r_1^B$, so borrowers face different credit market conditions after different actions. However, there will also be situations in which lender's do not learn any extra information upon observing borrower's action, and hence they charge exactly the same interest rate regardless of the action observed, i.e. $r_1^I = r_1^B$.

3.5 Sudden Stops and Sovereign Defaults

We model the borrower and lender interaction as a game. The borrower's strategy is to buy-back (B) or fresh issue (I) in period 1 and to pay or not in period

2. The lender's strategy is to set a break-even interest rates in each period. Given the information asymmetry described above, lenders will have beliefs about the borrower's type (shock realization in period 1). A Perfect Bayesian equilibrium (PBE) is an equilibrium in which everybody's response is optimal given everybody else's responses and beliefs, and beliefs are consistent with strategies and updates using Bayes' (whenever possible).

There are potentially to types of equilibria: Separating and Pooling.[12] In a separating equilibrium actions following each shock realization will be different (say issuing fresh debt only after a bad shock realization and buying back after a good one) and hence completely revealing. In this case, the equilibrium interest rates charged in period 1 will differ after each action, and hence $r_1^I \neq r_1^B$.[13]

On the other hand, in a pooling equilibrium actions following different shock realizations are the same (say the sovereign always decides to issue fresh debt). In this case, lenders cannot discriminate between different borrower and hence they charge the same interest rate, so $r_1^I = r_1^B = r_1$. This interest rate reflects somehow the average default probability across types.

We define a sudden stop (SS) as the shift in the supply curve of funds faced by the sovereign.[14] As explained before, we are not modeling the quantity choice, so issuance is taken exogenous. This not only keeps the model tractable, but also serves the purpose of studying the opposite extreme case from the one studied in the standard Sudden Stops literature. This literature defines a sudden stop as a sudden drop in the quantities issued without paying attention to prices. Our model will focus on endogenous and sudden changes in prices as opposed to quantities.

We will consider two measures of Sudden Stops (SS):

Definition 1: Time-Series Sudden Stop (TSS)

[12] In pure strategies. We are not considering mixed strategies in the model.

[13] In a separating equilibrium we get the full information equilibrium. Each interest rate will reflect each type's true probability of default. This is a consequence that in our model the space of signals, $\{B, I\}$ is as rich as the space of types $\{H, L\}$. If we were to add more types in our model, complete revelation would not happen anymore in a separating equilibrium, and hence asymmetric information would not only make pooling equilibrium possible but would also have an amplifying effect on pricing in the separating case. For this type of model see Catão , Fostel and Kapur (2008).

[14] For the purpose of the theoretical exposition we will consider any shift in supply as a SS. Of course, however, in reality not every shift in the supply of funds should be considered a SS. The concept of SS should only capture somehow "dramatic" events, and hence the definition should involve some kind of threshold definition. We will ignore this issue in the model, but will come back to this point in the conclusion when we propose ways to use his theoretical definition in empirical work, not only with the purpose of measuring SS in the data, but also as a early warning indicator.

We define a Time-Series Sudden Stop (TSS) as the difference in interest rates charged by lenders in period 0 and 1 after new issuance take place: $r_0 - r_1^I$.

Definition 2: Cross-Section Sudden Stop (CSS)

We define a Time-Series Sudden Stop (TSS) as the difference in interest rates charged by lenders in period 1: $r_1^I - r_1^B$.

The first definition (TSS) tries to capture worsening of credit conditions faced by a country through time. The second definition (CSS), tries to capture the worsening in credit conditions faced by a country as a consequence of taking a particular action. Clearly, in a separating equilibrium both types of SS would arise, whereas in a pooling equilibrium only a TSS could arise. The main result of the paper is the following.

Theorem 1: *There are two types of PBE equilibria in the model:*

1. *Separating Equilibrium:*
   In equilibrium the sovereign buys back debt after a good shock and issues fresh debt after a bad shock. A Sudden Stop (measured by TSS and CSS) associated with hiking spreads but positive net borrowing precedes a Sovereign Default.

2. *Pooling Equilibrium:*
   In equilibrium the sovereign issues fresh debt always. Cross-Section Sudden Stop does not occur before a Sovereign Default thought Times-Series Sudden Stop may occur.

Proof: See Appendix.

3.6 A No-Action game.

In this section we consider an alternative game set-up for the sake of completeness and robustness of our previous results. The model is exactly as before except that now the borrower after observing the realization of the shock in period one can take the following actions:

1. "No-Action" (N).

   In this case the borrower just pays interest payments due at time 1 and consume. He neither buy-back its debt as before nor issue new debt.

2. "Fresh Issuance" (I).

   In this case the borrower can issue new fresh one-period debt D_1 to cover potential fiscal downfalls. It issues $D_1 = \alpha\tau_1$, and promise to pay $(1 + r_1^I)\alpha\tau_1$ at $t = 2$. Notice that in this case total outstanding debt at the end of the middle period is larger than the stock of debt at time 0. The stock of debt at time 1 is $\alpha\tau_1 + \tau_0$ compared to the stock of debt at time 0, τ_0.

It is clear that non-action will not generate any market response, hence we will have at most two interest rates in the model: r_0 and r_1, the interest rate charged after fresh new issuance in the middle period.

Cash flows for lenders are slightly different now. Figure 15 describes the cash flow for a lender at $t = 0$. In period $t = 1$ the lender receives interest payments for sure $r_0\tau$. Then, with probability π the lender will turn out to be a H-type. In this case with some probability π^H the borrower will repay and in the second period and with probability $1 - \pi^H$ he will default. On the other hand, with probability $1 - \pi$ then borrower will end up being a L-type borrower. In this case with some probability π^L the borrower will repay and in the second period and with probability $1 - \pi^L$ he will default. Cash flows for lenders at $t = 1$ are the same before after new issuance.

Payoffs are in the new issuance case are exactly as before. Payoffs after buy back are given by $G_1 = F_1 r_0)\tau_0$ in period 1 and in period 2 by $G_2 = F_2 - (1 + r_0)\tau_0$ and $G_2 = F_2 - c(1 + dr_0)\tau_0 - \eta(\tau_2 + \rho\epsilon_1 + \tilde{\epsilon_2})$ in the case of repayment and default respectively.

Notice that now, our two definitions of Sudden Stops coincide. The cross-sectional default will also be measured by the difference between r_0 and r_1. Our main result in this case is the following:

Theorem 2: *There are two types of PBE equilibria in the model:*

1. *Separating Equilibrium:*
   In equilibrium the sovereign exerts no-action after a good shock and issues fresh debt after a bad shock. A Sudden Stop associated with hiking spreads but positive net borrowing precedes a Sovereign Default.

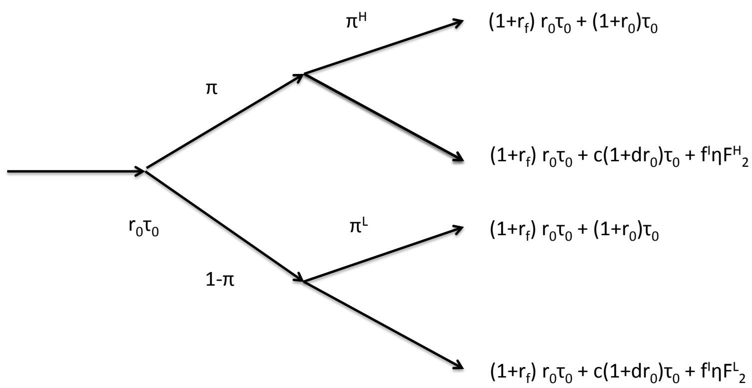

Figure 15: Lending at $t = 0$.

2. *Pooling Equilibrium:*
   In equilibrium the sovereign issues exerts no-action regardless of the shock realization. Sudden Stop does not occur before a Sovereign Default.

Proof: See Appendix.

4 Numerical Simulations

5 Conclusion

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Appendix

Proof of Theorem 1:

1. **Proof of Separating Equilibrium:**

The proof establishes that the strategies are optimal given beliefs and other player's strategies and beliefs are consistent with observed choices. Step 1 begins by assuming that the borrowers renegotiates after a good shock and issues new debt after a bad shock and establishes the optimality of all other choices and beliefs. Step 2 confirms the optimality of the period -1 borrowers strategy assumed before.

Step 1:

We assume that the borrower after receiving $\epsilon_1^H = \alpha\tau_1$ decides to follow strategy (B) and after receiving $\epsilon_1^L = -\alpha\tau_1$ decides to follow strategy (I). Total confiscation losses are given by η. In the case of re-issuance, I, a proportion of total confiscation $f^I = \frac{1}{1+\alpha}$ goes to creditors at time $t = 0$ and a proportion $1 - f^I = \frac{\alpha}{1+\alpha}$ goes to creditors at time $t = 1$. In the case of buy back, B, a a proportion of total confiscation $f^B = 0$ goes to creditors at time $t = 0$ and a proportion $1 - f^B = 1$ goes to creditors at time $t = 1$.

1. Lender's beliefs at $t = 1$.

   Clearly, lender's beliefs are given by $\mu(H/B) = 1$ and $\mu(L/I) = 1$. Hence, the equilibrium is completely revealing and hence lenders will charge two different interest rates at time $t = 1$: r_1^B and r_1^I.

2. Borrower's strategy at $t = 2$.

   Let us consider first the borrower that received a good shock in the middle period, an H-type. His revenue after repayment is $\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2} - (1 + r_1^B)\tau_0$. On the other hand, if he defaults his revenue is $\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_1^B)\tau_0 - \eta(\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence an H borrower repays at the end if and only if

   $$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 + \rho\alpha\tau_1)\eta + (1 + r_1^B)\tau_0 - c(1 + dr_1^B)\tau_0) = H_2 \qquad (8)$$

   Now, let us consider an L-type borrower. His revenue after repayment is $\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2} - (1+r_0)\tau_0 - (1+r_1^I)\alpha\tau_1$. On the other hand, if he defaults his revenue is $\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 - \eta(\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence an L borrower repays at the end if and only if

   $$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 - \rho\alpha\tau_1)\eta + (1+r_0)\tau_0 + (1+r_1^I)\alpha\tau_1 - c(1+dr_0)\tau_0 - c(1+dr_1^I)\alpha\tau_1) = L_2 \qquad (9)$$

   Note that in a separating equilibrium $H_2 < L_2$. We confirm this in section 4 with the numerical simulations. Before moving on to determine the pricing, notice that when we consider the last period shock, there are six cases from the lender's perspective:

   - Case 1: $H_2 < L_2 < \epsilon_2^L < \epsilon_2^H$. Nobody defaults.
   - Case 2: $H_2 < \epsilon_2^L < L_2 < \epsilon_2^H$. H never defaults, L only for a bad shock.
   - Case 3: $\epsilon_2^L < H_2 < L_2 < \epsilon_2^H$. Both default for a bad shock.
   - Case 4: $H_2 < \epsilon_2^L < \epsilon_2^H < L_2$. H never defaults, L always defaults.

- Case 5: $\epsilon_2^L < H_2 < \epsilon_2^H < L_2$. H defaults only for a bad shock. L always defaults.
- Case 6: $\epsilon_2^L < \epsilon_2^H < H_2 < L_2$. Both always default.

3. Lender's pricing at $t = 1$.

- Case 1: $H_2 < L_2 < \epsilon_2^L < \epsilon_2^H$. In this case

$$r_1^B = r_1^I = r_f \tag{10}$$

- Case 2: $H_2 < \epsilon_2^L < L_2 < \epsilon_2^H$. In this case r_1^B is given by equation (10). Break-even condition implies that $q(1+r_1^I)\alpha\tau_1 + (1-q)(c(1+dr_1^I)\alpha\tau_1 + (1-f^I)\eta F_2^{LL}) = (1+r_f)\alpha\tau_1$, where $F_2^{LL} = \tau_2 - \rho\alpha\tau_1 + \epsilon_2^L$. This gives

$$r_1^I = \frac{1+r_f}{q+(1-q)cd} - \frac{(q+(1-q)c)\alpha\tau_1 + (1-q)(1-f^I)\eta F_2^{LL}}{(q+(1-q)cd)\alpha\tau_1} \tag{11}$$

- Case 3: $\epsilon_2^L < H_2 < L_2 < \epsilon_2^H$. In this case r_1^I is given by equation (11). And by the same break-even logic we have that

$$r_1^B = \frac{1+r_f}{q+(1-q)cd} - \frac{(q+(1-q)c)\tau_0 + (1-q)(1-f^B)\eta F_2^{HL}}{(q+(1-q)cd)\tau_0} \tag{12}$$

  where where $F_2^{HL} = \tau_2 + \rho\alpha\tau_1 + \epsilon_2^L$

- Case 4: $H_2 < \epsilon_2^L < \epsilon_2^H < L_2$. In this case r_1^B is given by equation (10), and r_1^I is given by

$$r_1^I = \frac{1+r_f}{cd} - \frac{c\alpha\tau_1 + (1-f^I)\eta EF_2^L}{cd\alpha\tau_1} \tag{13}$$

  where $EF_2^L = qF_2^{LH} + (1-q)F_2^{LL}$, and $F_2^{LH} = \tau_2 - \rho\alpha\tau_1 + \epsilon_2^H$.

- Case 5: $\epsilon_2^L < H_2 < \epsilon_2^H < L_2$. In this case r_1^B is given by equation (12) and r_1^I by equation (13).
- Case 6: $\epsilon_2^L < \epsilon_2^H < H_2 < L_2$. In this case r_1^I is given by equation (13) and r_1^B by

$$r_1^B = \frac{1+r_f}{cd} - \frac{c\tau_0 + (1-f^B)\eta EF_2^H}{cd\tau_0} \tag{14}$$

  where $EF_2^H = qF_2^{HH} + (1-q)F_2^{HL}$ and $F_2^{HH} = \tau_2 + \rho\alpha\tau_1 + \epsilon_2^H$.

4. Lender's pricing at $t = 0$.

- Case 1: $H_2 < L_2 < \epsilon_2^L < \epsilon_2^H$. Break-even condition implies that $p((1 + r_0)(1 + r_f)\tau_0) + (1 - p)((1 + r_f)r_0\tau_0 + q(1 + r_0)\tau_0 + (1 - q)(1 + r_0)\tau_0) = (1 + r_f)^2\tau_0$. Which gives

$$r_0 = \frac{(1 + r_f)^2\tau_0 - (1 + r_f)\tau_0 p - (1 - p)\tau_0}{(1 + r_f)\tau_0 + (1 - p)\tau_0} \tag{15}$$

- Case 2: $H_2 < \epsilon_2^L < L_2 < \epsilon_2^H$. By the same break-even logic we have that

$$r_0 = \frac{(1 + r_f)^2\tau_0 - (1 + r_f)\tau_0 p - (1 - p)(q\tau_0 + (1 - q)c\tau_0 + (1 - q)f^I\eta F_2^{LL})}{(1 + r_f)\tau_0 + (1 - p)(q\tau_0 + (1 - q)cd\tau_0)} \tag{16}$$

- Case 3: $\epsilon_2^L < H_2 < L_2 < \epsilon_2^H$. In this case, r_0 is given by equation (16).
- Case 4: $H_2 < \epsilon_2^L < \epsilon_2^H < L_2$. In this case, by the same logic we have that

$$r_0 = \frac{(1 + r_f)^2\tau_0 - (1 + r_f)\tau_0 p - (1 - p)(c\tau_0 + f^I\eta EF_2^L)}{(1 + r_f)\tau_0 + (1 - p)cd\tau_0} \tag{17}$$

- Case 5: $\epsilon_2^L < H_2 < \epsilon_2^H < L_2$. In this case r_0 is given by equation (17).
- Case 6: $\epsilon_2^L < \epsilon_2^H < H_2 < L_2$. In this case r_0 is given by equation (17).

Step 2:

We first describe the payoffs of each type. Let us start with the L-type. His payoffs under no deviations, i.e. when playing the strategy assumed, I, are given by, first, in the case in which the borrower always repays:

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1) + E\tilde{\epsilon}_2) \tag{18}$$

when it repays only for a good shock:

$$\tau_1 - r_0\tau_0 + \beta(qP^R + (1 - q)P^D) \tag{19}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 - \eta F_2^{LL}$. Finally, when he always defaults

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 + E\tilde{\epsilon}_2 - \eta EF_2^L)) \tag{20}$$

There are two things that change when an L-type decides to deviate and play the B strategy after receiving a bad shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. After deviation his payoff after repayment at the end is given by $\tau_2 - \rho\alpha\tau_1 - (1 + r_1^B)\tau_0) + \tilde{\epsilon_2}$. After default is given by $\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_1^B)\tau_0 - \eta(\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 - \rho\alpha\tau_1)\eta + (1 + r_1^B)\tau_0 - c(1 + dr_1^B)\tau_0) = L_2^d \tag{21}$$

From equations (8), (9) and (21) it follows that $H_2 < L_2^d < L_2$.

His payoffs under deviations, i.e. when playing B, are given by, first, in the case in which the borrower always repays:

$$(1 - \alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1 + r_1^B)\tau_0) + E\tilde{\epsilon_2}) \tag{22}$$

when it repays only for a good shock:

$$(1 - \alpha)\tau_1 - r_0\tau_0 + \beta(qP^R + (1 - q)P^D) \tag{23}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1 + r_1^B)\tau_0$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1 + dr_1^B)\tau_0 - \eta F_2^{LL}$. Finally, when he always defaults:

$$(1 - \alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1 + dr_1^B)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^L)). \tag{24}$$

Next we describe the payoffs of the H-type. His payoffs under no deviations, i.e. when playing the strategy assumed, B, are given by, in the case in which the borrower always repays:

$$(1 + \alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1 + r_1^B)\tau_0) + E\tilde{\epsilon_2}) \tag{25}$$

when it repays only for a good shock:

$$(1 + \alpha)\tau_1 - r_0\tau_0 + \beta(qP^R + (1 - q)P^D) \tag{26}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1 + r_1^B)\tau_0$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1 + dr_1^B)\tau_0 - \eta F_2^{HL}$. Finally, when he always defaults:

$$(1 + \alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1 + dr_1^B)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^H)). \tag{27}$$

There are two things that change when an H-type decides to deviate and play the I strategy after receiving a good shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. After deviation his payoff after repayment at the end is given by $\tau_2 + \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1 + \tilde{\epsilon_2}$. After default is given by $\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 - \eta(\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2+\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1^I)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1^I)\alpha\tau_1) = H_2^d \tag{28}$$

From equations (8), (9) and (28) it follows that $H_2 < H_2^d < L_2$.

His payoffs under deviation, i.e. when playing I, are given by, first, in the case in which the borrower always repays:

$$(1 + 2\alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1 + E\tilde{\epsilon_2}) \tag{29}$$

when it repays only for a good shock:

$$(1 + 2\alpha)\tau_1 - r_0\tau_0 + \beta(qP^R + (1 - q)P^D) \tag{30}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1 + r_0)\tau_0 - (1 + r_1^I)\alpha\tau_1$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1 + dr_0)\tau_0 - c(1 + dr_1^I)\alpha\tau_1 - \eta F_2^{HL}$. Finally, when he always defaults:

$$(1+2\alpha)\tau_1 - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1+dr_0)\tau_0 - c(1+dr_1^I)\alpha\tau_1 + E\tilde{\epsilon_2} - \eta EF_2^H)) \tag{31}$$

Finally, in order to check for the existence of a separating equilibrium, we need to check for possible deviations for each type. We have two cases in terms of thresholds: I) $H_2 < H_2^d < L_2^d < L_2$ and II) $H_2 < L_2^d < H_2^d < L_2$. Note, however, that for pricing we still just need to consider the six original cases since investors cannot observe deviations. However, in order to check for deviations some of these six cases may get subdivided in sub-cases, when we consider also the deviation thresholds. Tables 1 and 2 show all the possible cases that we need to check. For example, in case 4.1) in table 1 in order to check for deviation we need to show that equation (25) is bigger than equation (29) for the H type and that equation (20) is bigger than equation (22) for the L-type using pricing according to case 4 discussed in step 1. Clearly, there will be parameter values that can sustain a separating equilibrium. This is ultimately a numerical question, which we discuss extensively in section 4.

2. Proof of Pooling Equilibrium:

In this case Step 1 begins by assuming that the borrowers issue new debt after regardless of the shock value and establishes the optimality of all other choices and beliefs. Step 2 confirms the optimality of the period-1 borrowers strategy assumed before.

Step 1:

We assume that the borrower after receiving $\epsilon_1^H = \alpha\tau_1$ and $\epsilon_1^L = -\alpha\tau_1$ the borrower decides to follow strategy I. Total confiscation losses are given by η of which a proportion $f^I = \frac{1}{1+\alpha}$ goes to creditors at time $t = 0$ and a proportion $1 - f^I = \frac{\alpha}{1+\alpha}$ goes to creditors at time $t = 1$.

1. Lender's beliefs at $t = 1$.

   Lender's beliefs are given by the prior distribution, so $\mu(H) = p$ and $\mu(L) = 1 - p$. Hence, the equilibrium is not revealing and lenders will charge a unique interest rate in the intermediate period, r_1.

2. Borrower's strategy at $t = 2$

   Let us consider first the H-type. His revenue after repayment is $\tau_2 + \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1)\alpha\tau_1 + \tilde{\epsilon_2}$. On the other hand, if he defaults his revenue is $\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - c(1 + dr_1)\alpha\tau_1 + \eta(\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence H repays if and only if

   $$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2+\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = H_2 \quad (32)$$

   Now, let us consider an L-type borrower. His revenue after repayment is $\tau_2 - \rho\alpha\tau_1 - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1 + \tilde{\epsilon_2}$. On the other hand, if he defaults his revenue is $\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - c(1 + dr_1)\alpha\tau_1 + \eta(\tau_2 1\rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence L repays if and only if

   $$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2-\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = L_2 \quad (33)$$

3. Lender's pricing at $t = 1$.

   As before, there are six relevant cases from the pricing perspective.

- Case 1: $H_2 < L_2 < \epsilon_2^L < \epsilon_2^H$. In this case

$$r_1 = r_f \tag{34}$$

- Case 2: $H_2 < \epsilon_2^L < L_2 < \epsilon_2^H$. Break-even condition implies that $p((1+r_1)\alpha\tau_1) + (1-p)(q(1+r_1)\alpha\tau_1 + (1-q)(c(1+dr_1)\alpha\tau_1 + (1-f^I)\eta F_2^{LL})) = (1+r_f)\alpha\tau_1$, where $F_2^{LL} = \tau_2 - \rho\alpha\tau_1 + \epsilon_2^L$. This gives

$$r_1 = \frac{1+r_f}{p+(1-p)(q+(1-q)cd)} - \frac{w + (1-p)(1-q)(1-f^I)\eta F_2^{LL}}{(p+(1-p)(q+(1-q)cd))\alpha\tau_1} \tag{35}$$

where $w = \alpha\tau_1(p + (1-p)(q+(1-q)c))$.

- Case 3: $\epsilon_2^L < H_2 < L_2 < \epsilon_2^H$. By the same break-even logic we have that

$$r_1 = \frac{1+r_f}{q+(1-q)cd} - \frac{(q+(1-q)c)\alpha\tau_1 + (1-q)(1-f^I)\eta(pF_2^{HL} + (1-p)F_2^{LL})}{(q+(1-q)cd)\alpha\tau_1} \tag{36}$$

where where $F_2^{HL} = \tau_2 + \rho\alpha\tau_1 + \epsilon_2^L$

- Case 4: $H_2 < \epsilon_2^L < \epsilon_2^H < L_2$. In this case r_1 is given by

$$r_1 = \frac{1+r_f}{p+(1-p)cd} - \frac{(p+(1-p)c)\alpha\tau_1 + (1-p)(1-f^I)\eta EF_2^L}{(p+(1-p)cd)\alpha\tau_1} \tag{37}$$

where $EF_2^L = qF_2^{LH} + (1-q)F_2^{LL}$, and $F_2^{LH} = \tau_2 - \rho\alpha\tau_1 + \epsilon_2^H$.

- Case 5: $\epsilon_2^L < H_2 < \epsilon_2^H < L_2$. In this case r_1 is given by

$$r_1 = \frac{1+r_f}{p(q+(1-q)cd) + (1-p)cd} - \frac{w + p(1-q)(1-f^I)\eta F_2^{HL} + (1-p)(1-f^I)\eta EF_2^L}{(p(q+(1-q)cd) + (1-p)cd)\alpha\tau_1} \tag{38}$$

where $w = (p(q+(1-q)c) + (1-p)c)\alpha\tau_1$.

- Case 6: $\epsilon_2^L < \epsilon_2^H < H_2 < L_2$. In this case r_1 is given by

$$r_1 = \frac{1+r_f}{cd} - \frac{c\alpha\tau_1 + (1-f^I)\eta(pEF_2^H + (1-p)EF_2^L)}{cd\tau_1\alpha} \tag{39}$$

where $EF_2^H = qF_2^{HH} + (1-q)F_2^{HL}$ and $F_2^{HH} = \tau_2 + \rho\alpha\tau_1 + \epsilon_2^H$.

4. Lender's pricing at $t = 0$.

- Case 1: $H_2 < L_2 < \epsilon_2^L < \epsilon_2^H$. Break-even condition implies that $r_0\tau_0(1+$

$r_f) + (1 + r_0)\tau_0 = (1 + r_f)^2\tau_0$. Which gives

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0}{(1 + r_f)\tau_0 + \tau_0} \tag{40}$$

- Case 2: $H_2 < \epsilon_2^L < L_2 < \epsilon_2^H$. By the same break-even logic we have that

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0(p + (1 - p)(q + (1 - q)c)) - (1 - p)(1 - q)f^I\eta F_2^{LL}}{(1 + r_f)\tau_0 + \tau_0(p + (1 - p)(q + (1 - q)cd))} \tag{41}$$

- Case 3: $\epsilon_2^L < H_2 < L_2 < \epsilon_2^H$. In this case, r_0 is given by

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0(q + (1 - q)c) - (1 - q)f^I\eta(pF_2^{HL} + (1 - p)F_2^{LL})}{(1 + r_f)\tau_0 + \tau_0(q + (1 - q)cd)} \tag{42}$$

- Case 4: $H_2 < \epsilon_2^L < \epsilon_2^H < L_2$. In this case, by the same logic we have that

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0(p + (1 - p)c) - (1 - p)f^I\eta EF_2^L}{(1 + r_f)\tau_0 + \tau_0(p + (1 - p)cd)} \tag{43}$$

- Case 5: $\epsilon_2^L < H_2 < \epsilon_2^H < L_2$. In this case r_0 is given by

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0(p(q + (1 - q)c) + (1 - p)c) - p(1 - q)f^I\eta F_2^{HL} - (1 - p)f^I\eta EF_2^L}{(1 + r_f)\tau_0 + \tau_0(p(q + (1 - q)cd) + (1 - p)cd)} \tag{44}$$

- Case 6: $\epsilon_2^L < \epsilon_2^H < H_2 < L_2$. In this case r_0 is given by

$$r_0 = \frac{(1 + r_f)^2\tau_0 - \tau_0 c - f^I\eta(pEF_2^H + (1 - p)EF_2^L)}{(1 + r_f)\tau_0 + \tau_0 cd} \tag{45}$$

Step 2:

We first describe the payoffs of each type. Let us start with the L-type. His payoffs under no deviations, i.e. when playing the strategy assumed, I, are given by, first, in the case in which the borrower always repays:

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1)\alpha\tau_1) + E\tilde{\epsilon}_2) \tag{46}$$

when it repays only for a good shock:

$$\tau_1 - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{47}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - c(1+dr_1)\alpha\tau_1 - \eta F_2^{LL}$. Finally, when he always defaults

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1+dr_0)\tau_0 - c(1+dr_1)\alpha\tau_1 + E\tilde{\epsilon_2} - \eta EF_2^L)) \tag{48}$$

There are two things that change when an L-type decides to deviate and play the B strategy after receiving a bad shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. After deviation his payoff after repayment at the end is given by $\tau_2 - \rho\alpha\tau_1 - (1+r_1^B)\tau_0 + \tilde{\epsilon_2}$. After default is given by $\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1+dr_1^B)\tau_0 - \eta(\tau_2 - \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 - \rho\alpha\tau_1)\eta + (1+r_1^B)\tau_0 - c(1+dr_1^B)\tau_0) = L_2^d \tag{49}$$

His payoffs under deviations, i.e. when playing B, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1+r_1^B)\tau_0) + E\tilde{\epsilon_2}) \tag{50}$$

when it repays only for a good shock:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{51}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1+r_1^B)\tau_0$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_1^B)\tau_0 - \eta F_2^{LL}$. Finally, when he always defaults:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1+dr_1^B)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^L)). \tag{52}$$

Next we describe the payoffs of the H-type. His payoffs under no deviations, i.e. when playing the strategy assumed, I, are given by, in the case in which the borrower always repays:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1 + E\tilde{\epsilon_2}) \quad (53)$$

when it repays only for a good shock:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \quad (54)$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - c(1+dr_1)\alpha\tau_1 - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1+dr_0)\tau_0 - c(1+dr_1)\alpha\tau_1 + E\tilde{\epsilon_2} - \eta EF_2^H)) \quad (55)$$

There are two things that change when an H-type decides to deviate and play the B strategy after receiving a good shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. After deviation his payoff after repayment at the end is given by $\tau_2 + \rho\alpha\tau_1 - (1+r_1^B)\tau_0 + \tilde{\epsilon_2}$. After default is given by $\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2} - c(1+dr_1^B)\tau_0 - \eta(\tau_2 + \rho\alpha\tau_1 + \tilde{\epsilon_2})$. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 + \rho\alpha\tau_1)\eta + (1+r_1^B)\tau_0 - c(1+dr_1^B)\tau_0) = H_2^d \quad (56)$$

His payoffs under deviation, i.e. when playing B, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_1^B)\tau_0) + E\tilde{\epsilon_2}) \quad (57)$$

when it repays only for a good shock:

$$\tau_1(1+\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \quad (58)$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_1^B)\tau_0$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_1^B)\tau_0 - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau_1(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1+dr_1^B)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^H)). \quad (59)$$

In order to check for the existence of a I-pooling equilibrium, we need to check for possible deviations for each type.Finally, from equations (32) and (33) we know that

$H_2 < L_2$. From equations (49) and (56) we know that $H_2^d < L_2^d$. But the relative order of H_2 with respect to H_2^d and of L_2 with respect to L_2^d is not known ex-ante. So again we have two cases in order to check for deviations: I) $H_2^d < H_2 < L_2^d < L_2$ and II) $H_2 < H_2^d < L_2 < L_2^d$. As before it is the case that for pricing we still just need to consider the six original cases since investors cannot observe deviations. However, in order to check for deviations some of these six cases may get subdivided in sub-cases, when we consider also the deviation thresholds. Tables 3 and 4 show all the possible cases that we need to check. Clearly, there will be parameter values that can sustain a I-pooling equilibrium. This is ultimately a numerical question, which we discuss extensively in section 4.

Proof of Theorem 2:

1. Proof of Separating Equilibrium:

Step 1:

We assume that the borrower after receiving $\epsilon_1^H = \alpha\tau_1$ decides to follow strategy (N) and after receiving $\epsilon_1^L = -\alpha\tau_1$ decides to follow strategy (I). Total confiscation losses are given by η. In the case of re-issuance, I, a proportion of total confiscation $f = \frac{1}{1+\alpha}$ goes to creditors at time $t = 0$ and a proportion $1 - f = \frac{\alpha}{1+\alpha}$ goes to creditors at time $t = 1$.

1. Lender's beliefs at $t = 1$.

   Lender's beliefs are given by $\mu(H/N) = 1$ and $\mu(L/I) = 1$.

2. Borrower's strategy at $t = 2$.

   Let us consider first the borrower that received a good shock in the middle period, an H-type. His revenue after repayment is $\tau_2 + \rho\epsilon_1^H + \tilde{\epsilon_2} - (1 + r_0)\tau_0$. On the other hand, if he defaults his revenue is $\tau_2 + \rho\epsilon_1^H + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - \eta(\tau_2 + \rho\epsilon_1^H + \tilde{\epsilon_2})$. Hence an H borrower repays at the end if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 + \rho\alpha\tau_1)\eta + (1 + r_0)\tau_0 - c(1 + dr_0)\tau_0) = H_2 \qquad (60)$$

   Now, let us consider an L-type borrower. His revenue after repayment is $\tau_2 + \rho\epsilon_1^L + \tilde{\epsilon_2} - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1$. On the other hand, if he defaults his revenue is $\tau_2 + \rho\epsilon_1^L + \tilde{\epsilon_2} - c(1 + dr_0)\tau_0 - c(1 + dr_1)\alpha\tau_1 - \eta(\tau_2 + \rho\epsilon_1^L + \tilde{\epsilon_2})$. Hence an L

borrower repays at the end if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2-\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = L_2 \tag{61}$$

3. Lender's pricing at $t = 1$.

   r_1 is given by the same equations as r_1^I was given in the separating equilibrium in Theorem 1, equations (10), (11), (13) and (14).

4. Lender's pricing at $t = 0$.

   Pricing at $t = 0$ in each of the six cases is given by the same equations as in the pooling equilibrium in Theorem 1, equations (40)-(45) with only one modification: in equations (42), (44) and (45) we replace the fiscal confiscation ηf^I for the H type for η.

Step 2:

We first describe the payoffs of each type. Let us start with the L-type. His payoffs under no deviations, i.e. when playing the strategy assumed, I, are given by, first, in the case in which the borrower always repays:

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1 + r_0)\tau_0 - (1 + r_1)\alpha\tau_1) + E\tilde{\epsilon_2}) \tag{62}$$

when it repays only for a good shock:

$$\tau_1 - r_0\tau_0 + \beta(qP^R + (1 - q)P^D) \tag{63}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1 + r_0)\tau_0 - (1 + r_1)\alpha\tau_1$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1 + dr_0)\tau_0 - c(1 + dr_1)\alpha\tau_1 - \eta F_2^{LL}$. Finally, when he always defaults

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1 + dr_0)\tau_0 - c(1 + dr_1)\alpha\tau_1 + E\tilde{\epsilon_2} - \eta EF_2^L)) \tag{64}$$

There are two things that change when an L-type decides to deviate and play the B strategy after receiving a bad shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. By the same logic as before, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 - \rho\alpha\tau_1)\eta + (1+r_0)\tau_0 - c(1+dr_0)\tau_0) = L_2^d \tag{65}$$

His payoffs under deviations, i.e. when playing B, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1+r_0)\tau_0 + E\tilde{\epsilon_2}) \tag{66}$$

when it repays only for a good shock:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{67}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - \eta F_2^{LL}$. Finally, when he always defaults:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1+dr_0)\tau_0 + E\tilde{\epsilon_2} - \eta E F_2^L)). \tag{68}$$

Next we describe the payoffs of the H-type. His payoffs under no deviations, i.e. when playing the strategy assumed, N, are given by, in the case in which the borrower always repays:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_0)\tau_0 + E\tilde{\epsilon_2}) \tag{69}$$

when it repays only for a good shock:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{70}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1+dr_0)\tau_0 + E\tilde{\epsilon_2} - \eta E F_2^H)). \tag{71}$$

There are two things that change when an H-type decides to deviate and play the I strategy after receiving a good shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. By the same logic as before, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2+\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = H_2^d \tag{72}$$

His payoffs under deviation, i.e. when playing I, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1) + E\tilde{\epsilon_2}) \tag{73}$$

when it repays only for a good shock:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{74}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - c(1+dr_1)\alpha\tau_1 - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau_1(1+2\alpha)-r_0\tau_0+\beta(\tau_2+\tau_1\rho\alpha-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1+E\tilde{\epsilon_2}-\eta EF_2^H)) \tag{75}$$

Finally, in order to check for the existence of a separating equilibrium, we need to check for possible deviations for each type. For that we follow exactly the same procedure as in theorem 1. The cases are completely analogous.

2. Proof of Pooling Equilibrium:

Step 1:

We assume that the borrower after receiving $\epsilon_1^H = \alpha\tau_1$ and $\epsilon_1^L = -\alpha\tau_1$ the borrower decides to follow strategy N.

(a) Lender's beliefs at $t = 1$.

Lender's beliefs are given by the prior distribution, so $\mu(H) = p$ and $\mu(L) = 1 - p$.

(b) Borrower's strategy at $t = 2$

Let us consider first the H-type. By the same logic as before we have that

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 + \rho\alpha\tau_1)\eta + (1+r_0)\tau_0 - c(1+dr_0)\tau_0) = H_2 \tag{76}$$

Now, let us consider an L-type borrower. L repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2 - \rho\alpha\tau_1)\eta + (1+r_0)\tau_0 - c(1+dr_0)\tau_0) = L_2 \tag{77}$$

(c) Lender's pricing at $t = 1$.

There is no credit market at 1.

(d) Lender's pricing at $t = 0$.

Pricing at $t = 0$ in each of the six cases is given by the same equations as in the pooling equilibrium in Theorem 1, equations (40)-(45) with one modification: in all equations we substitute ηf^I for η.

Step 2:

We first describe the payoffs of each type. Let us start with the L-type. His payoffs under no deviations, i.e. when playing the strategy assumed, N, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1+r_0)\tau_0) + E\tilde{\epsilon_2}) \tag{78}$$

when it repays only for a good shock:

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{79}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - \eta F_2^{LL}$. Finally, when he always defaults

$$\tau_1(1-\alpha) - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1+dr_0)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^L)) \tag{80}$$

There are two things that change when an L-type decides to deviate and play the I strategy after receiving a bad shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2-\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = L_2^d \tag{81}$$

where r_1 is given by the value in the separating proof.

His payoffs under deviations, i.e. when playing I, are given by, first, in the case in which the borrower always repays:

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \rho\alpha\tau_1 - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1 + E\tilde{\epsilon_2}) \tag{82}$$

when it repays only for a good shock:

$$\tau_1 - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{83}$$

where $P^R = \tau_2 - \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0 - (1+r_1)\tau_1\alpha$ and $P^D = \tau_2 - \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - c(1+dr_1)\tau_1\alpha - \eta F_2^{LL}$. Finally, when he always defaults:

$$\tau_1 - r_0\tau_0 + \beta(\tau_2 - \tau_1\rho\alpha - c(1+dr_0)\tau_0 - c(1+dr_1)\tau_1\alpha + E\tilde{\epsilon_2} - \eta EF_2^L)). \tag{84}$$

Next we describe the payoffs of the H-type. His payoffs under no deviations, i.e. when playing the strategy assumed, N, are given by, in the case in which the borrower always repays:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_0)\tau_0 + E\tilde{\epsilon_2}) \tag{85}$$

when it repays only for a good shock:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(qP^R + (1-q)P^D) \tag{86}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau(1+\alpha) - r_0\tau_0 + \beta(\tau_2 + \tau_1\rho\alpha - c(1+dr_0)\tau_0 + E\tilde{\epsilon_2} - \eta EF_2^H) \tag{87}$$

There are two things that change when an H-type decides to deviate and play the I strategy after receiving a good shock in the middle period: the second period repayment threshold and his payoffs. Let us first describe the deviation threshold. Hence, he repays if and only if

$$\tilde{\epsilon_2} \geq (1/\eta)(-(\tau_2+\rho\alpha\tau_1)\eta+(1+r_0)\tau_0+(1+r_1)\alpha\tau_1-c(1+dr_0)\tau_0-c(1+dr_1)\alpha\tau_1) = H_2^d \tag{88}$$

His payoffs under deviation, i.e. when playing I, are given by, first, in the case in which the borrower always repays:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(\tau_2 + \rho\alpha\tau_1 - (1+r_0)\tau_0 - (1+r_1)\alpha\tau_1 + E\tilde{\epsilon_2}) \tag{89}$$

when it repays only for a good shock:

$$\tau_1(1+2\alpha) - r_0\tau_0 + \beta(q + (1-q)P^D) \tag{90}$$

where $P^R = \tau_2 + \tau_1\rho\alpha + \epsilon_2^H - (1+r_0)\tau_0 - (1+r_1)\tau_1\alpha$ and $P^D = \tau_2 + \tau_1\rho\alpha + \epsilon_2^L - c(1+dr_0)\tau_0 - c(1+dr_1)\tau_1\alpha - \eta F_2^{HL}$. Finally, when he always defaults:

$$\tau_1(1+2\alpha)-r_0\tau_0+\beta(\tau_2+\tau_1\rho\alpha-c(1+dr_0)\tau_0-c(1+dr_1)\tau_1\alpha+E\tilde{\epsilon_2}-\eta EF_2^H)). \tag{91}$$

In order to check for the existence of a I-pooling equilibrium, we need to check for possible deviations for each type.This is analogous to procedure in theorem 1.