

Learning and Optimal Delay in Bargaining over Sovereign Debt Restructuring

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Abstract

We model bargaining with a sovereign subject to a moral hazard problem. The country can implement a better economic policy which will increase its future revenues, but doing so comes at a personal cost to the sovereign. The lender can only observe imperfect signals of the country's policy choice and set debt forgiveness and the number of signals required indicating that the country has implemented the good policy. With imperfect signals, welfare reducing bargaining delay may occur. In some cases both lender payoff and total welfare may improve with less precise signals. We offer an explanation why sovereign debt restructuring, such as in the recent case of Greece, can take a long time and why lenders have to collect information on the country's progress during renegotiations.

JEL classification: C79, D82, F34, H63

Keywords: Sovereign Debt, Bargaining, Delay, Learning, Renegotiations

1 Introduction

The Greek debt crisis which started in late 2009 is still unresolved.¹ Despite efforts by national governments and supranational organizations, no resolution has yet been found despite the massive costs for both the people of Greece and the countries in the Euro zone. Despite the costs, representatives of EU governments and the IMF spent countless hours brokering deals, that sometimes fell apart, and agreeing on economic reforms that are not fully implemented yet. Greece's financial woes and their maneuvering with the creditor troika of the Eurozone countries, the European Central Bank (ECB), and the International Monetary Fund (IMF) are a regular occurrence in the news. Such a lengthy restructuring process is not unique to this particular example. Empirically we can observe a large variation in the length of the sovereign debt restructuring process which can vary from a few months to over a decade with an average of 28 months (Das, Papaioannou, and Trebesch (2012)). In this paper we offer an explanation to why such costly delays may occur.

We present a model which demonstrates how the dynamic between a sovereign and a "privileged" creditor can lead to delays in renegotiation post default. Here we use the term privileged to characterize lenders of last resort, such as the IMF and Paris club, who will step in and provide loans for amounts or for rates unavailable to the sovereign through the financial markets. They are privileged in the sense that their clout and reputation allows them to credibly demand reforms, set terms for delinquent creditors, and negotiate terms of a bailout. Restructuring in our setting is welfare improving whenever the country implements structural reforms to its economy to ensure its ability to serve its restructured debt in the long run. Frictions arise in our bargaining model as the lender can not perfectly observe whether the country has implemented the good policy. Lenders can only learn over time and form a belief about the state of the country's policy from imperfect signals they get to observe. We assume that a change in economic policy is costly to the country, which therefore has an incentive to stick with the bad policy and hope that lender falsely believes otherwise and will sign off on the restructuring.

When designing the restructuring plan, the lender in our model has two mechanisms to

¹Europe is still affected by a sovereign debt crisis post the 2008 financial crisis. Ireland, Portugal, and Greece lost access to credit markets and required the assistance of the Eurogroup to refinance debt. In Greece, this resulted in the largest sovereign debt default in history of US\$138 billion (the record was formerly US\$82 billion held by Argentina in 2001). The resulting haircut on Greek debt in 2012 was over 50% and now it appears that even that amount is unsustainable.

incentivize the country to implement the good economic policy: First, the lender can offer more debt relief, which allows the country to keep a larger part of the surplus. A more favorable offer to the sovereign makes waiting more costly to the country which therefore implements the good economic policy sooner rather than later. The use of a carrot in the form of sovereign debt relief to motivate political or financial change within a country is quite common.² For example, the following rewards were offered to Greece³ should they meet conditions of the restructuring program and once they reached a primary surplus: (i) A lowering by 100 bps of the interest rate charged to Greece on the loans provided in the context of the Greek loan facility, (ii) A lowering by 10 bps of the guarantee fee costs paid by Greece on the European Financial Stability Facility (EFSF) loans, and (iii) an extension of the maturities of the bilateral and EFSF loans by 15 years and a deferral of interest payments of Greece of EFSF loans by 10 years.

Second, the lender can push a country towards implementing a good economic policy through harsher monitoring, i.e. demanding more positive signals from the country indicating that it has implemented the good policy. This monitoring causes inefficient bargaining delay and reduces welfare but often proves better for the lender. The imposition of economic reforms by privileged lenders often faces stiff resistance in creditor countries. Meeting the demands of privileged creditors can be quite costly or politically inconvenient. Argentina often bemoaned the political and economic interference of the IMF after their 2001 default, and Greece's battle against the troika became a central election issue.

While offering less debt relief in general increases lenders profit, we find that lenders have to offer a minimum level of debt relief to ensure that the country implements the good economic policy. Harsher monitoring will also provide an incentive to implement the good policy but will cause bargaining delay. The optimal mix of debt relief and monitoring is driven by the lender's monitoring technology. In practice financial data signals from sovereigns can be very noisy. As per the requirements for entry into the Eurozone, Greece reported a deficit below 3% of GDP for 1999. In 2000, Greece was accepted as the 12th member of the European Monetary Union. In March 2002, September 2002, and again in March 2004: Eurostat refused to validate the fiscal data sent by the Greek government. Each time, this forced the National Statistics Service of Greece to revise the debt level upwards and revealed a deficit when a surplus was originally reported. Post the 2004 election, Greece sent yet again revised data to Eurostat which revealed

²For a discussion of historical nation-to-nation politically incentivized loans see Oosterlinck (2013)

³November 27, 2012 Eurogroup statement

defecit levels above 3% of GDP for 1999 and triggering much controversy regarding their entry into the Euro. A damning 2010 Eurostats report⁴ included implications of political interference and falsification. Deficit reporting irregularities have also turned up for Portugal and Italy. It is clear that data sent from these sovereigns regarding fiscal behaviours are noisy at best.

Given lack of reliability in the signals from the sovereigns, we allow for the privileged creditor to delay the administration of the reward to the sovereign for their good behaviour. The intent of this delay is to give the creditor time to more accurately judge the signals as they will be more difficult to fake in the longer term. Castro, Pérez, and Rodríguez-Vives (2013) has found that, in Europe, the initially reported data contains significantly lower deficits and higher surpluses as compared with later revisions. They found that it takes 2 years (4 reporting cycles) of revisions for the data to be considered accurate. This is in line with our model's prediction that in many cases it is beneficial to implement a delayed reward requiring multiple good signals.

An increased ability for a country to deceive its creditors generally reduces the profit for the lenders and lowers overall welfare but may be beneficial for the country. As the country's implementation of the good economic policy gets harder to verify, the lenders first respond by offering more debt relief. At some point, however, harsher monitoring is optimally implemented by the lenders causing longer bargaining delay. Since delay is more costly for the country than for the lenders, the country is substantially worse off and welfare decreases as the country's ability to deceive increases. The relationship between a country's payoff from debt restructuring and its ability to deceive is therefore non-monotonic.

Our model is consistent with several stylized facts on debt restructurings. Benjamin and Wright (2009) and Cruces and Trebesch (2013) document a positive correlation between haircuts and negotiation delays which arises in our model endogenously from the lender's optimal tradeoff between debt relief and harsher monitoring. Our model also predicts a negative relationship between the ability of a lender to verify the country's economic policy and the length of a sovereign debt restructuring, which is consistent with the stylized facts on debt restructuring. We can see this relationship borne out in recent restructurings in which the IMF played a part (Figure 1). We utilize the same set of restructurings as in Erce (2013). As information Unreliability Measure (UM) we use the absolute difference between the near-term IMF predic-

⁴European Commission: Report on Greek government deficit and debt statistics. January 8, 2010

tion for GDP growth and the ex-post revised value 2 years later. There is a clearly observable positive relationship between this ex-post UM (Figure 1a) and delay in restructuring (P-value of 0.044). At the time of decision making this ex-post UM isn't available so we also checked the most recent available UM - for instance, in 2000, the most recent UM was 1998. Figure 1b shows this relationship, and while not as clear as the ex-post case the relationship between restructuring length and unreliability of economic information is still present (P-value 0.069).

Our paper does not examine the optimal default threshold of a sovereign creditor. Default usually occurs post crisis rather than strategically (Yeyati and Panizza 2011), with the recent exception being Ecuador in 2008. Our model starts post crisis where the sovereign has already defaulted and deals with how to handle the renegotiation landscape.

The two most closely related papers in the literature are Bi (2008) and Benjamin and Wright (2009) as they both endogenize the delay in renegotiation post default. Bi (2008), analyzes the case in which it may be beneficial for both borrowers and lenders to delay renegotiation until the economy in the country recovers so that the pie to be divided is larger. He models a stochastic output stream, with no state contingent debt repayment schemes. If state-contingent repayment schedules are available, delays are unnecessary. In our paper the equivalent to the output stream (sustainable debt level) is endogenous to the decisions of the parties. Benjamin and Wright (2009) expand the framework from Bi (2008) by allowing the renegotiation of a new loan contract (as opposed to simply making a payment to the creditors).

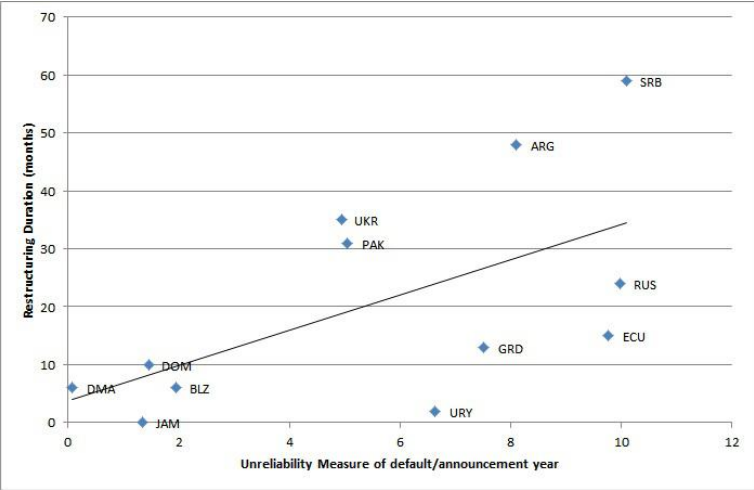
The rest of the paper is organized as follows: Section 2 presents the model setup, Section 3 contains the solution of the model, Section 4 discusses the results, and Section 6 concludes.

2 Model

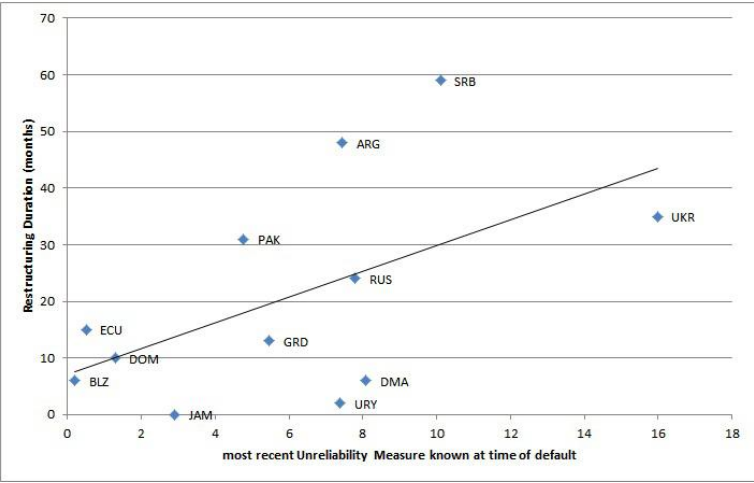
Assume that two players, a sovereign country and a lender negotiate about restructuring the country's debt. Denote the outstanding face value of the country's debt before renegotiations as F . The country can follow two alternative economic policies p which we label good (G) and bad (B) for simplicity. The country's economy and its tax revenues can support outstanding debt with a face value of $D_G < F$ under the good policy and $D_B < D_G$ under the bad policy. To simplify the exposition of the paper we assume that $D_B = 0$. It is common knowledge that

Figure 1. Empirical observations on the relationship between information uncertainty and delay in IMF restructurings (1996-2010)

a) ex-post uncertainty in IMF World Economic Outlook GDP growth (top panel)



b) ex-ante uncertainty in IMF World Economic Outlook GDP growth (bottom panel)



the country is currently following the bad policy. A switch to the good policy is irreversible and entails a cost c for the country.

The country and the lender bargain over a new debt level d . We focus by assumption on the interesting case where an agreement is only viable when the country implements the good economic policy. Any remaining debt capacity $D_G - d$ can be used to improve the welfare of the country's citizens, e.g. by financing infrastructure projects. The lender gets a new debt claim with reduced value d , which we assume to be riskless for simplicity.

The friction in bargaining that we examine in this paper comes from the fact that it is unobservable to the lender whether the country switches to the good policy or not. However, over time the lender gets signals about the country's economy that allow her to learn the country's chosen economic policy. Specifically, assume that at each point in time $t \in \{1, 2, \dots\}$ the lender obtains an informative binary signal $s_t \in \{H, L\}$ with

$$P(s_t = H) = \begin{cases} 1 & \text{if } p = G \\ \theta & \text{if } p = B \end{cases} \quad (1)$$

We think of the signal as a report to the troika in the case of Greece in 2016 on the progress of implementing a reform measures that will allow the country to get back on a financially sustainable path. Since the signal is imperfect and there is a cost to the country to implement the necessary measures to move towards the good economic policy, the country has an incentive to cheat and claim that it has implemented the necessary reforms while still sticking to the bad policy.

The focus of this paper is the analysis on the delay in resolution of sovereign defaults. We therefore build a stylized bargaining model that captures several characteristic features of observed sovereign debt restructurings. At $t = 0$ the lender commits to forgive $F - d$ of the country's outstanding debt given a certain belief whether the country has implemented the good policy. Whenever the lender gets a low (L) signal they know for certain that the country has not yet implemented the good economic policy and that any new debt level they agree to is unsustainable as it is above the country's debt capacity. To be convinced that the country has implemented the good policy, the lender demands that the country produces n consecutive high (H) signals before debt forgiveness will be implemented. We allow the lender, which we think of as the IMF or the Paris Club, to make credible commitments through an unmodeled repu-

tation mechanism because of frequent interactions with countries in sovereign default. Note, however, that even though the lender can commit and has all the bargaining power, the asymmetric information on the country's policy limits her effective bargaining power. If the lender is too tough, the country will not pay the cost of the policy change and gamble to get enough good signals to resolve the crisis. In this case, the creditors could end up with a worthless claim.

At the beginning of each subsequent period $t \in \{1, 2, \dots\}$ the country can, if it has not yet done so, change to the good economic policy at cost c . Then the lender observes a costless signal s_t according to the technology in Equation (1). If the country has produced n consecutive high signals the game ends and the previously committed new debt level d gets implemented. If the country has implemented the good policy the creditors obtain a new claim worth d and the country can spend $D_G - d$ to benefit its citizens. Furthermore we assume that the country gets a benefit B from restructuring its debt irrespective of the financial policy it has implemented. We interpret this benefit as the ability of a country to access international debt markets and finance short term payments to finance necessary imports or to pay public salaries and pensions.

Ongoing renegotiations are costly for both parties. The lenders often do not get any payments during the default and have to devote time and resources to the restructuring process. In the long run they would benefit from trade relationships once the country has successfully restructured their debt. The country will clearly also benefit from renewed access to financial markets as it could implement necessary infrastructure projects, boost its domestic growth, and reduce frictions in international trade. We therefore assume that both creditors and the country discount future payoffs from the restructuring game with discount factors of ρ and δ , respectively.

3 Solution

We solve the game by backward induction. First, we examine the country's optimal choice of policy for a given restructuring plan by the lender. Then, we solve for the optimal restructuring plan given that the lender either wants to maximize its ex-ante payoff or maximize total welfare.

3.1 The country's problem

Assume a restructuring plan, consisting of a new debt level d and a required number of consecutive high signals n , as given. Once the lender has observed n consecutive good signals, the game ends and the country's payoff depends on the policy p it has implemented.

At any number of consecutive high signals $j < n$ high signals the country's payoff if it has implemented to good economic policy, C^G , is given by:

$$C^G(j, n) = \delta^{(n-j)}(B + D^G - d) \quad (2)$$

Once the country has implemented the good policy it will only produce good signals and hence just has to wait until n signals are observed by the lender, in which case the restructuring plan will be implemented giving the country a benefit of B from accessing markets and a payoff from free debt capacity of $D^G - d$.

If the country has not yet implemented the good policy and has obtained j high signals, its payoff $C^B(j, n)$ depends on its choice of economic policy. It can implement the good policy this period at a cost c , after which it will obtain the payoff $C^G(j + 1, n)$ next period or it can stay with the bad policy. In this case it can either produce a high signal with probability θ , in which case it will get an expected payoff of $C^B(j + 1, n)$ next period, or a low signal with probability $(1 - \theta)$. The bad signal will reveal that the country chose the bad policy in which case its expected payoff next period will be $C^B(0, n)$.

We can therefore define the payoff for the country under the bad policy as:

$$C^B(j, n) = \begin{cases} B & \text{if } j = n, \text{ the game ends} \\ \delta C^G(j + 1, n) - c & \text{if } j < n, \text{ country switches to } p = G \\ \delta (\theta C^B(j + 1, n) + (1 - \theta)C^B(0, n)) & \text{if } j < n, \text{ country stays with } p = B \end{cases} \quad (3)$$

The costs of shirking increase for the bad country in the number of already observed good signals. Suppose for example that the country has already produced $n - 1$ subsequent good signals. By shirking it can save the cost of implementing the good policy but if caught all its credibility will be lost and its expected payoff reverts back to the starting point. The other polar

case is a country that has just produced a bad signal. Such a debtor has little to lose as it is already common knowledge that the bad policy is in place. A country with no positive signals might therefore find it optimal to gamble and thus postpone paying the cost of a policy change to a later period.

To solve the system of difference equations (2) and (3), we restrict the country's strategy space in our analysis to trigger strategies under which the country will implement the good policy once a certain number $k \in \{0, \dots, n\}$ of good signals have been observed. The two boundary cases of $k = 0$ and $k = n$ represent the strategy to immediately or never implement the good policy, respectively.

Proposition 1 *The country's expected payoff at time zero given that it will switch to the good economic policy after observing k consecutive good signals is given as*

$$C_0(n, k) = C^B(0, n, k) = \frac{(\delta\theta - 1)\theta^k ((D_g - d)\mathbf{1}_{k < n} + B)\delta^n - c\delta^k \mathbf{1}_{k < n}}{\delta + (\theta - 1)\delta^{k+1}\theta^k - 1} \quad (4)$$

The country will then set k to maximize its expected payoff from renegotiations.

$$k^* = \arg \max_k C_0(n, k) \quad (5)$$

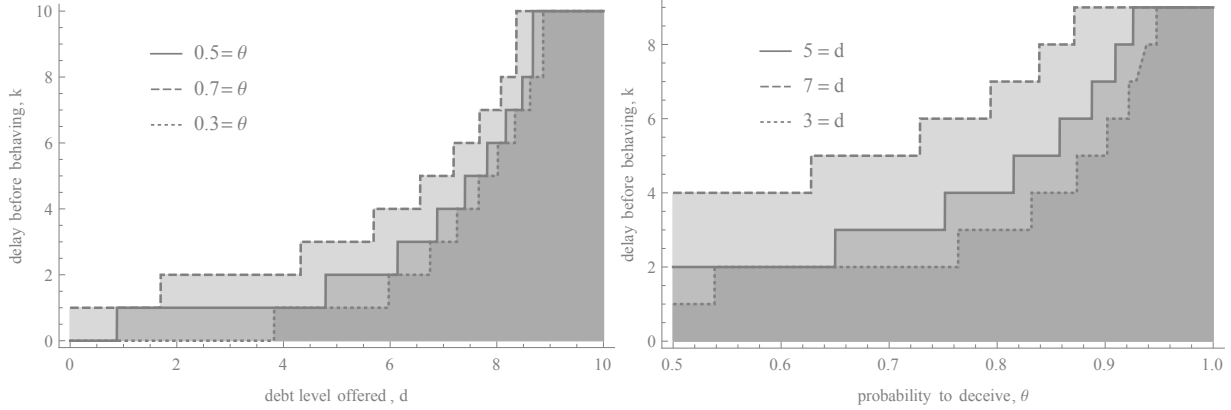
The optimal k , denoted as k^* can only be found numerically. Figure 2 illustrates some of the results of our model. A sweeter deal for the country (lower debt level, d) incentivizes them to behave earlier in order to capture the gains of the lower debt level. We therefore see k^* increasing in d (left panel). A less transparent reporting environment (higher θ) results in an increased delay before the good policy is adopted as the country can put off the cost to a future period (right panel).

3.2 The lender's problem

We first consider the optimal restructuring plan that the lender imposes when maximizing ex-ante profit. Since delay is costly, the lender has to balance a higher payoff once the game ends

Figure 2. The country's problem: The best response delay in terms of good signals as a function of new debt level (left panel) and probability of faking a good signal (right panel).

$\{D_g = 10, D_b = 0, B = 1.2, \delta = 0.9, \theta = 0.5, c = 1.8, \rho = 0.98\}$



by asking for a higher face value of outstanding debt d with the speed of getting an agreement. It is only rational for the lender to agree to a restructuring once the good economic policy has been implemented. Offering the country a higher reward by forgiving more debt creates an incentive for the country to implement the good policy sooner.

We again write the lender's payoff in terms of the number j of consecutive high signals observed. If $j = n$ the country has fulfilled the terms of the restructuring plan and the game ends. The lender then obtains.

$$L(n, n, k) = \begin{cases} d & \text{if } n \geq k \\ 0 & \text{if } n < k \end{cases} \quad (6)$$

The lender's expected payoff in previous periods depends on the country's choice of economic policy. If $j \geq k$ the lender rationally anticipates that the country has implemented the good policy in which case there is a deterministic path to end of the game such that

$$L(j, n, k) = \rho L(j + 1, n, k) \text{ if } j \geq k \quad (7)$$

Otherwise the lender rationally anticipates the country to cheat in which case the expected

payoff depends on the signal being

$$L(j, n, k) = \rho (\theta L(j + 1, n, k) + (1 - \theta)L(0, n, k)) \text{ if } j < k \quad (8)$$

Credible commitment on the side of the lender is necessary to support this equilibrium. Most sovereign defaults are negotiated by institutions like the IMF or the Paris Club that interact with defaulted states on a reoccurring basis and can therefore build up a credible reputation better than most individual creditors could. We solve the system of difference Equations (6), (7), and (8) to find the lender's optimal renegotiated debt level d and the required number of consecutive high signals n .

Proposition 2 *The lender's expected payoff at time 0 is*

$$L_0(n) = L(0, n, k^*) = \frac{d(\theta\rho - 1)\theta^{k^*}\rho^n}{(\theta - 1)\theta^{k^*}\rho^{k^*+1} + \rho - 1} \quad (9)$$

where k^* is given by Equation (5).

3.3 Welfare

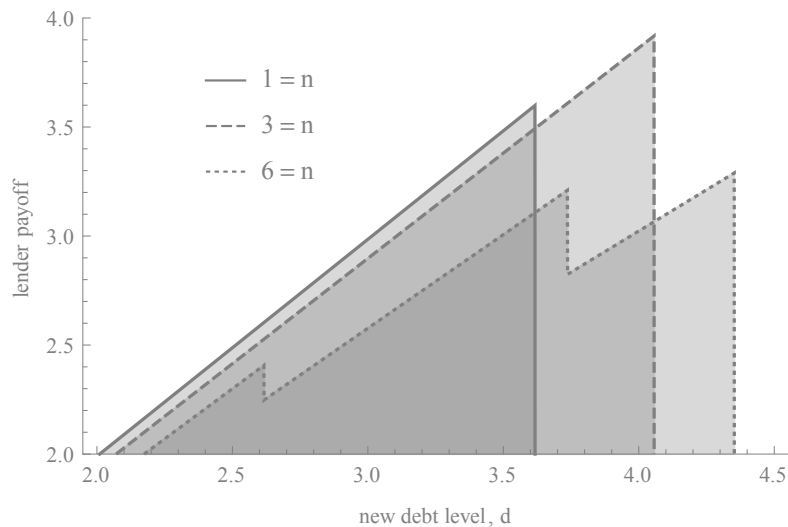
Economic inefficiencies occur in our model for two reasons. First, as long as the costs of switching policy are not too high, implementing the good economic policy is efficient.⁵ When the incentive to gamble is too strong the country might find it optimal to stick with the inefficient bad policy in hoping to avoid paying the switching cost. Second, delay in bargaining is inefficient whenever bargaining delay is costly for either the country or the lender, i.e. either $\delta < 1$ or $\rho < 1$.

For the purpose of this paper we define welfare W as the combined payoff to the lender and the country, i.e.

$$W(n) = L_0(n) + C_0(n, k^*) \quad (10)$$

⁵Throughout the paper we assume that the cost of switching policy c is less than the benefits $D_G - d + B$.

Figure 3. The lender's problem: Lender payoff response to new debt levels for various fixed good signal requirements (n). $\{D_g = 10, D_b = 0, B = 1.9, \delta = 0.9, \theta = 0.5, c = 5.9, \rho = 0.995\}$



4 Bargaining

The lender in our model has all the bargaining power in setting the bailout terms, specifically they set the number of required good signals n as well as the new face value of debt d . Yet, the lender has to consider that the bailout terms will also drive the behavior of the country: whether or not to implement the good economic policy and if so, after how many good signals. Incentivizing the country to implement the good economic policy can be costly in two ways to the lender: first, the lender can lower d , the face value of debt, leaving a larger payoff $D_G - d$ for the country whenever it implements the good policy. More debt forgiveness, however, reduces the lender's payoff. Second, the lender can set tougher terms by demanding more good signals n before granting debt relief. The more evidence the lender demands in the form of more good signals, the harder it is for the country to gamble for the required number of good signals. Requiring more good signals, however, is also costly to the lender as it delays bargaining and the payoffs.

Optimally the lender will choose bailout terms (n^*, d^*) that maximize their expected payoff taking into account the country's optimal response k^* . The bailout terms together with the country's ability to cheat, θ , will determine the bargaining delay. Lemma 3 summarizes the

relationship. Note that n^* is a function of k^* so a static comparison is not possible. The bottom-left panel of Figure 5 illustrates the non-monotonic relationship between θ and the expected bargaining delay.

Lemma 3 *The expected bargaining delay is given by*

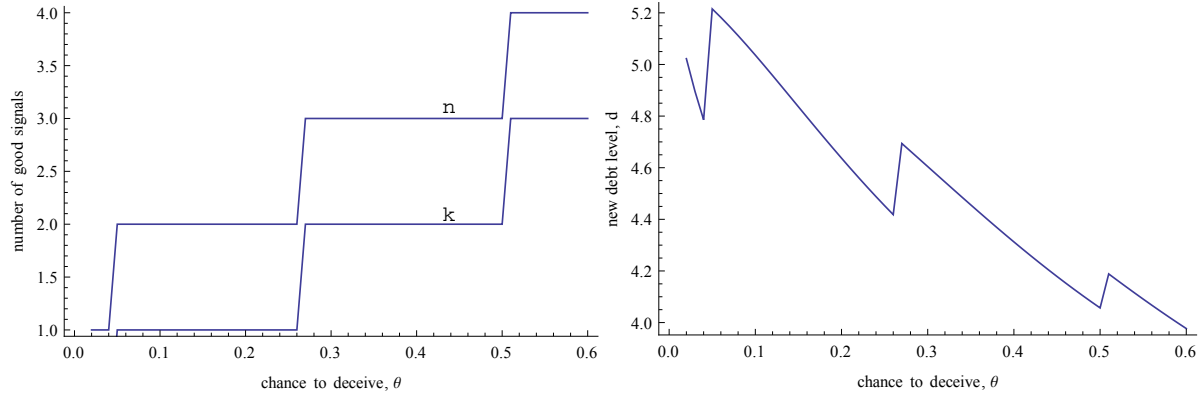
$$\tau = \frac{\theta^{-k^*} - 1}{1 - \theta} + (n^* - k^*) \quad (11)$$

Figure 3 illustrates the tradeoff the lender faces when setting the bailout terms. The graph shows the lender's profit for a different number of required good signals. On the x-axis are different levels of new debt. The lower the debt forgiveness (the higher the level of the newly restructured debt, d), the higher the lender's payoff as long as the incentives are preserved for the country to implement the good economic policy. If the lender sets the new debt level too high, the country will stick to the bad policy and the lender's payoff drops sharply. For a given number of required good signals there is this a maximum debt level that the lender can set to get the country to comply.

To force the country into implementing the good policy for higher levels of debt, the lender can ask for more good signals. Since delay is costly the country will still have an incentive to implement the good policy as the lender demands a higher level of new debt. Requiring more good signals, however, causes delay in bargaining which is also costly for the lender. For a given level of renegotiated debt, the lender will thus always ask for the smallest number of good signals that still preserves the country's incentive to implement the good policy. The lender thus faces a tradeoff where demanding a higher debt level in bargaining will increase their profit but when that debt level can only be achieved by demanding a higher number of good signals then the resulting delay will reduce their expected payoff. In the example illustrated in Figure 3 the lender will optimally choose to demand three good signals and offer a new debt level of 4.05. The best response for the country will then be to wait for 2 good signals before switching to the good economic policy, resulting in an expected payoff of 3.91 for the lender.

The ability of a country to produce a false good signal, θ , is one of the key drivers that determined the optimal bailout terms that the lender offers. Figure 4 illustrates this tradeoff. As the country finds it easier to "cheat" (θ increases), the lender has to offer more debt forgiveness, i.e., a lower d (right panel). Additionally, the lender will find it optimal, in line with the mechanism

Figure 4. The impact of a country’s ability to cheat on a new debt contract: The resulting required number of good signals (n) and the number of good signals a country will shirk for (k) (left panel) - new contract debt level (d) (right panel) $\{D_g = 10, D_b = 0, B = 1.9, \delta = 0.9, c = 5.9, \rho = 0.995\}$



illustrated in Figure 3, to demand more good signals before granting debt relief (left panel) as the country’s ability to cheat increases. Whenever the lender increases the number of required good signals, i.e. they take out a bigger stick, they have to offer a larger carrot, meaning that they offer more debt relief, demanding a lower d .

Figure 5 plots several important variables with respect to the country’s ability to cheat. The expected profit that the lender can make generally decreases with the country’s ability to generate positive signals while still not yet having implemented the good policy. Interpreting a lower θ as the lender having a better monitoring technology, it is not surprising that better monitoring in general allows the lender to extract more in bargaining. The lender’s expected payoff is, however, not always monotonic in the monitoring technology. For some levels of θ the lender would be better off if it was easier to cheat. The reason has to do with the discrete nature of the signaling and requirements, discounting of the lender’s payoff, combined with the tradeoff between more negotiating power from a delay increase and less negotiating power from information asymmetry. Whenever the lender decides to increase the number of required good signals, the expected bargaining delay increases substantially as can be seen in the bottom-left panel of Figure 5 and from Lemma 3. Increasing the number of required signals allows the lender to extract a higher level of debt in renegotiations as the lender is more patient. When this increase is driven by information asymmetry in signaling, however, further increases in θ before the next discrete jump in n^* solely act to giving negotiating power to the country.

Figure 5. The effects of a country's ability to cheat: Lender payoff (top left) - Country payoff (top right) - Delay (bottom left) - Welfare (bottom right)

$$\{D_g = 10, D_b = 0, B = 1.9, \delta = 0.9, c = 2, \rho = 0.995\}$$

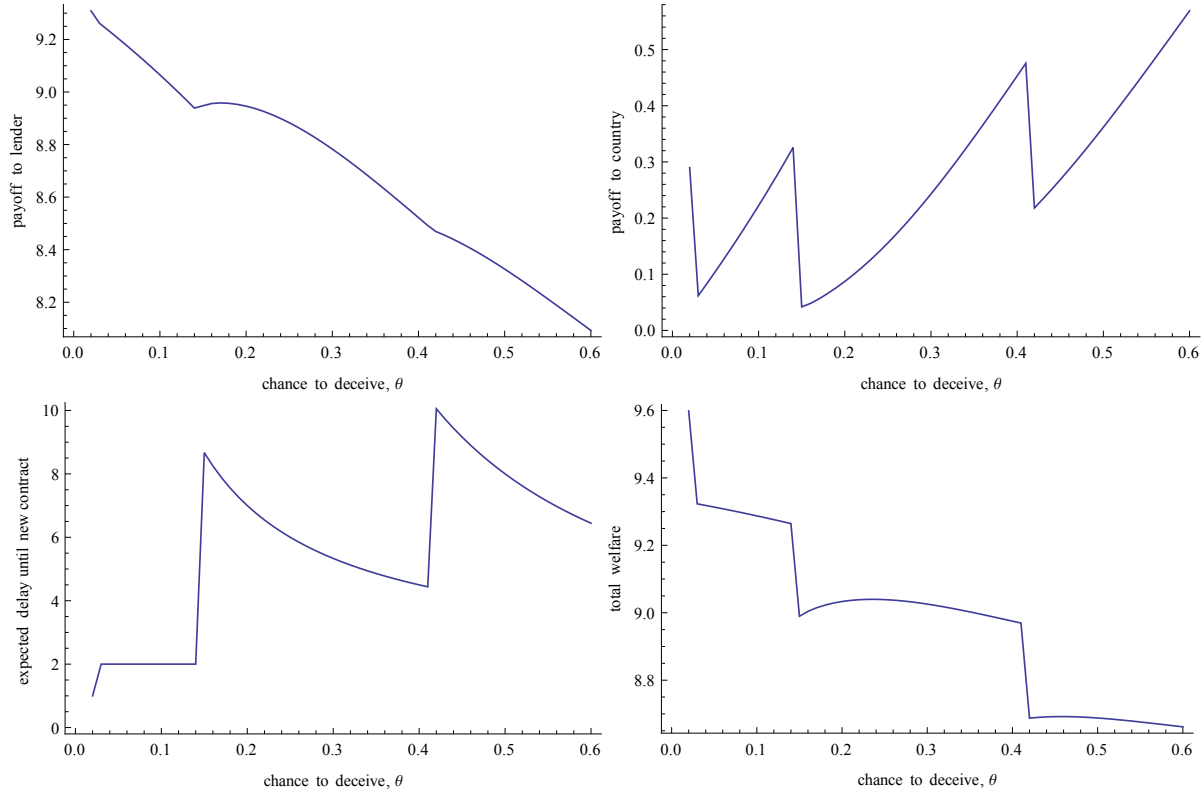
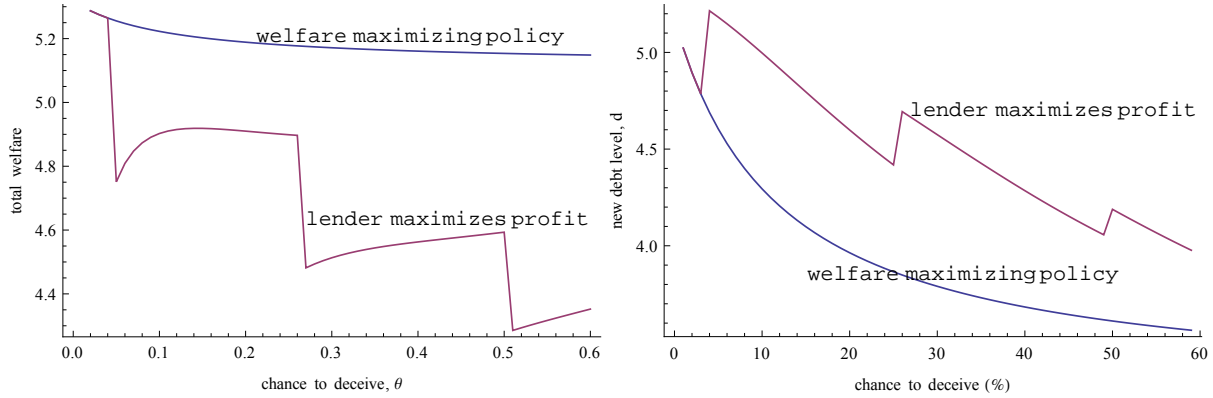


Figure 6 illustrates some implications regarding welfare: First, total welfare is not monotonic in the country's ability to cheat θ (left panel). The reasoning is similar to the previous paragraph and has to do with the discrete nature of fiscal reporting. As a policy maker, one would need to be careful of blindly pushing for small gains to transparency in an environment where creditors are free to profit maximize. However, when large gains to transparency are achievable, in general it should reduce efficiency loss. Second, the new debt level is lower when maximizing welfare as compared to the creditor profit maximizing. If a policy maker is concerned with total welfare, say the well being of the Eurozone as a whole, interference may be needed in the normal negotiation balance to the detriment of the creditors. The result of which would be a lower debt level for the sovereign.

Figure 6. A comparison between optimal welfare and maximum lender profit decision making: A country's ability to cheat and the effect on total welfare (left panel) and new debt level (right panel) $\{D_g = 10, D_b = 0, B = 1.9, \delta = 0.9, c = 5.9, \rho = 0.995\}$



5 Extensions

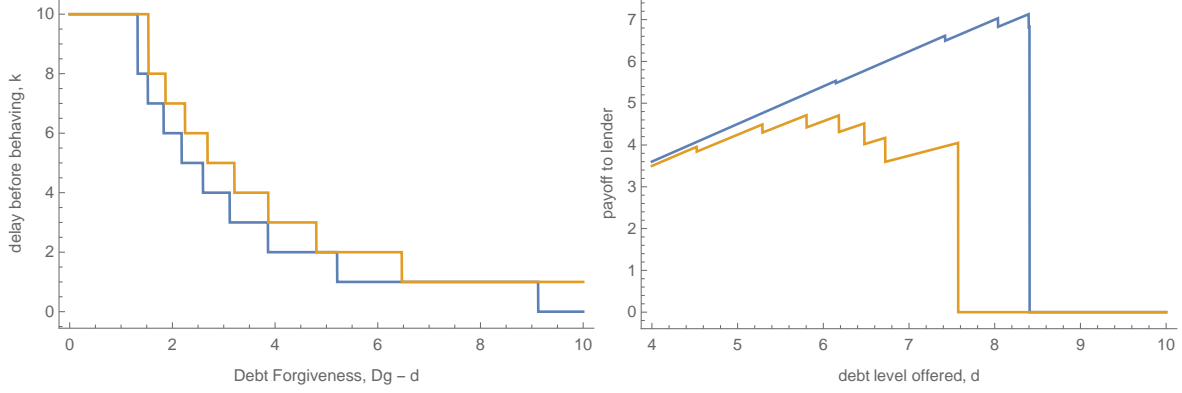
5.1 Lucky economic recovery

We extend our base case model to include the possibility for the economy of the country to improve through no action taken on the part of the government (i.e. luck). This could take many forms such as: a sudden increase in prices of exports, global economic recovery, or unexpected technological breakthrough. This lucky recovery increases the supportable debt burden and would produce good economic signals (the same as those seen under good behaviour) at no cost to the country. Formally we let the country at the beginning of each period exogenously switch to the good economic policy with probability ϕ .

Proposition 4 *The country's expected payoff at time zero when there is a possibility of a lucky economic recovery, ϕ per period, given that it will switch to the good economic policy after observing k consecutive good signals is given as*

Figure 7. Shift seen when a lucky economic recovery is possible: $\phi = 2\%$

The shift in strategy for the country (left panel), and the decrease in payoff for the lender at given new debt level (right panel)



$$\begin{aligned}
 E_0(n, k) &= E^B(0, n, k) \\
 &= \frac{\delta^{-k}(\delta\theta(\phi - 1) + 1) \left(E_{recovery} \phi \delta^n \left(\left(\frac{1}{\theta - \theta\phi} \right)^k - 1 \right) + E_k(n, k)(\theta(\phi - 1) + 1)\delta^k \right)}{(\theta(\phi - 1) + 1) \left(\delta(\theta - 1)(\phi - 1) + (\delta(\phi - 1) + 1) \left(\frac{1}{\delta\theta - \delta\theta\phi} \right)^k \right)}
 \end{aligned} \tag{12a}$$

Where $E_k(n, k)$ is the value to the borrower of behaving after obtaining k good signals

$$E_k(n, k) = E^B(k, n, k) = [(D_g - d)\mathbf{1}_{k < n} + B]\delta^{n-k} - c\mathbf{1}_{k < n} \tag{12b}$$

and $E_{recovery}$ is the non-discounted value of a lucky economic recovery when/if it occurs. For illustration we use

$$E_{recovery} = (D_g - d) + B \tag{12c}$$

As seen in Figure 7, the country will delay the implementation of the good policy when a lucky recovery is possible. This forces the lender to offer a lower debt level to incentivize the good behaviour.

6 Conclusion

Our model offers a rational explanation for the bargaining delay that is often observed in sovereign debt restructurings such as the one currently occurring in Greece. Lenders define the restructuring plan in terms of debt forgiveness and auditing to incentivize the country to switch to a long term sustainable economic policy. Bargaining delay and welfare loss increase with the country's ability to cheat as the lenders demand more signals confirming that the good policy has been implemented. Our findings are in agreement with Trebesch (2010) who found that weak institutions and strategic government behaviour are dominant drivers of restructuring delay.

The analysis of our paper has important policy implications for the restructuring of sovereign debt. Welfare is maximized in a regime where the country's choice of economic policy is as transparent as possible to the lenders. The country itself, however, might be better off in a regime where it is harder to verify its policy choice so that it can extract better terms from the lenders. The lenders, in turn, will demand more evidence that the country has implemented the good policy which will cause bargaining delay in equilibrium. Stricter auditing of economic progress will be both in the country's as well as the lenders interest when benefits from speedy restructuring are shared.

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A Proofs

Proof of Proposition 1. The value to the borrower at the point they have decided to behave (after observing k good signals by chance) is given by equation (13). This is a simple discounting of $(n - k)$ periods on the forthcoming reward after n good signals of $D_g - d + B$, minus the cost paid now of c . In the event that $n = k$ neither the cost nor the benefit from the writedown occurs (as only the lower debt level, $D_b=0$, is sustainable).

$$C_k(n, k) = C^B(k, n, k) = (((D_g - d)\mathbf{1}_{k < n} + B)\delta^{n-k} - c\mathbf{1}_{k < n}) \quad (13)$$

At $(k - 1)$ good signals, in one period the borrower will either get lucky and end up at k good signals or have to start over at 0 good signals. From our value of $C_k(n, k)$, we can recursively calculate a value at $(k - 1)$ good signals:

$$C_{k-1}(n, k) = \theta C_k(n, k)\delta + (1 - \theta)C_0(n, k)\delta \quad (14a)$$

Likewise, the value at $(k - 2)$ good signals can be calculated from $C_{k-1}(n, k)$:

$$C_{k-2}(n, k) = \theta C_{k-1}(n, k)\delta + (1 - \theta)C_0(n, k)\delta \quad (14b)$$

⋮

$$C_j(n, k) = \theta C_{j+1}(n, k)\delta + (1 - \theta)C_0(n, k)\delta \quad (14c)$$

⋮

$$C_0(n, k) = \theta C_1(n, k)\delta + (1 - \theta)C_0(n, k)\delta \quad (14d)$$

This series of equations can be solved for $C_k(n, k)$ in terms of $C_0(n, k)$, where $k \geq 1$:

$$C_k(n, k) = C_0(n, k) \frac{1}{\delta^k \theta^k} - C_0(n, k) \sum_{i=0}^{k-1} \left(\frac{1 - \theta}{\theta} \right) \left(\frac{1}{\delta \theta} \right)^i \quad (15a)$$

$$= C_0(n, k) \frac{1}{\delta^k \theta^k} - C_0(n, k) \left(\frac{1 - \theta}{\theta} \right) \left[\frac{1 - \left(\frac{1}{\delta \theta} \right)^k}{1 - \left(\frac{1}{\delta \theta} \right)} \right] \quad (15b)$$

Substituting equation (13) into (15b) and solving for $C_0(n, k)$ yields equation (4):

$$C_0(n, k) = C^B(0, n, k) = \frac{(\delta \theta - 1)\theta^k (((D_g - d)\mathbf{1}_{k < n} + B)\delta^n - c\delta^k \mathbf{1}_{k < n})}{\delta + (\theta - 1)\delta^{k+1}\theta^k - 1}$$

■

Proof of Proposition 2. This proof utilizes the same method as the proof for proposition 1. For any chosen number of required good signals, n , and new debt level, d , the lender knows the best response for the country in terms of the number of good signals to wait for before behaving, k^* . The value of the payoff for the lender after k^* good signals is therefore:

$$L_{k^*}(n) = L(k^*, n, k^*) = d\rho^{n-k^*} \quad (16)$$

At $(k^* - 1)$ good signals, in one period the borrower will either get lucky and end up at k^* good signals or have to start over at 0 good signals. From our value of $L_{k^*}(n)$, we can recursively calculate a value at $(k^* - 1)$ good signals:

$$L_{k^*-1}(n) = \theta L_{k^*}(n)\rho + (1 - \theta)L_0(n)\rho \quad (17a)$$

Likewise, the value at $(k - 2)$ good signals can be calculated from $L_{k-1}(n)$:

$$L_{k^*-2}(n) = \theta L_{k^*-1}(n)\rho + (1 - \theta)L_0(n)\rho \quad (17b)$$

⋮

$$L_j(n) = \theta L_{j+1}(n)\rho + (1 - \theta)L_0(n)\rho \quad (17c)$$

⋮

$$L_0(n) = \theta L_1(n)\rho + (1 - \theta)L_0(n)\rho \quad (17d)$$

This series of equations can be solved for $L_{k^*}(n)$ in terms of $L_0(n)$, where $k^* \geq 1$:

$$L_k(n) = L_0(n)\frac{1}{\rho^k\theta^k} - L_0(n)\sum_{i=0}^{k-1}\left(\frac{1-\theta}{\theta}\right)\left(\frac{1}{\rho\theta}\right)^i \quad (18a)$$

$$= L_0(n)\frac{1}{\rho^k\theta^k} - L_0(n)\left(\frac{1-\theta}{\theta}\right)\left[\frac{1 - \left(\frac{1}{\rho\theta}\right)^k}{1 - \left(\frac{1}{\rho\theta}\right)}\right] \quad (18b)$$

Substituting equation (16) into (18b) and solving for $L_0(n)$ yields equation (9):

$$L_0(n) = L(0, n, k^*) = \frac{d(\theta\rho - 1)\theta^{k^*}\rho^n}{(\theta - 1)\theta^{k^*}\rho^{k^*+1} + \rho - 1}$$

■

B Addressing self-fulfilling crises

There is a potential worry that when a creditor can implement different interest rates, or payment schemes, multiple equilibria can occur which leads to a self-fulfilling prophecy of sorts. If the creditor sets a high interest rate, then the high payments by the sovereign may be unsustainable after a shock and thus increase the chance of future default. In contrast, a very low interest rate (low payments required) decreases the chance of future default. This is dealt with by Calvo (1988), and in the extreme the creditor can demand the risk free rate, which results in the sovereign being able to, and choosing to, pay back the debt. On the other hand, a risk premium leads to the interest payments accumulating to the point where the debt is unsustainable.

Several papers have shown that this self-fulfilling prophecy scenario is highly mitigated. Cohen and Portes (2006) shows this process is interrupted if efficient ex-post debt restructuring is possible after default. Chamon (2007) shows that some adjustment to the negotiation process can remove the threat. Multiple equilibria can occur if the country announces the amount it wants to borrow today and then the creditors reply with an interest rate. However, they show multiple equilibria are impossible when the amount it will pay back tomorrow is announced and the creditors reply with the interest rate.⁶ As bond issuance and auction by sovereigns follows this latter scenario, we do not think offering a choice of interest rates/debt levels to the lender poses significant self-fulfilling crises complications in our model setup.

⁶Cohen and Villemot (2011) shows that a self-fulfilling crises can still occur in the event that a debt crisis significantly reduces the fundamentals of the sovereign (flight of capital, exchange rate crisis). They estimate that 6-12% of recent debt crises could be self-fulfilling.