Risk profiles for re-profiling the sovereign debt of crisis countries

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September 2014.

Working Paper 14-14
The Wharton Financial Institutions Center
The Wharton School, University of Pennsylvania, PA

Abstract

This paper uses a risk-management approach to re-profiling the sovereign debt of countries facing debt crises. Using scenario analysis we develop a risk measure of the sovereign’s debt —Conditional Debt-at-Risk— and an optimization model is used to trace risk profiles that tradeoff expected cost of debt financing against the Conditional Debt-at-Risk. The risk profiles are particularly informative for crisis countries, as they allow us to identify, with high-probability, debt unsustainability. We develop risk profiles for two Eurozone countries with excessive debt, Cyprus and Italy, both in their current form and under various forms of restructuring or rescheduling, and show how to assess debt sustainability. We also develop the risk profiles for a proposal to impose “debt sanctions” in the Ukrainian crisis and show that the (financial) impact could be substantial.

Keywords: sovereign debt restructuring; sustainability analysis; scenario analysis; optimization; stochastic programming; Cyprus crisis; Italy; Ukrainian crisis; debt sanctions.

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1 The need for sovereign debt reform

As Argentina was declared in default yet one more time by Standard & Poor’s on 30th July 2014, the debate on the need for reforms in the sovereign debt market is intensifying. In the aftermath of the Greek PSI in 2012, whereby private creditors “voluntarily” transferred 106 billion euro to Greece, there has been broad recognition that the system for dealing with sovereign debt crises is not working. Joseph Stiglitz wrote on August 1 that “a global system is needed for debt restructuring”, echoing suggestions made in 2001 by a United Nations Commission of Experts he had chaired. Kenneth Rogoff argued on July 7 that “it is high time for a conversation on debt relief for the entire eurozone periphery”. These and other likely-minded policy-blog posts are summarized in a Bruegel compendium1.

In the meantime the Executive Board of the IMF has been discussing reforms to its lending framework, IMF (2013). In particular, the Fund would likely eliminate the systemic risk waiver, which allowed lending to countries with unsustainable debt, and introduce instead the possibility of maturity extensions. In a similar vein, the proposal by Gianviti et al. (2010) suggests a procedure for conducting negotiations between a sovereign debtor with unsustainable debt and its creditors, leading to restructuring of the debtor’s obligations to reestablish sustainability. They argue for the need of a special court to deal with such cases, and they suggest that a special chamber of the Court of Justice of the European Union would be the appropriate institution. The decision in 2012 by Judge Thomas Griesa of the Southern District Court of New York, in favour of the holdouts from the 2005 debt restructuring of Argentina, has turned upside-down current practices for sovereign debt default. The need for a special court chamber to deal consistently with these complex cases appears well justified.

Through all these events and discussions we see sovereign debt restructuring emerging as an important policy tool. There has even been a proposal to use debt restructuring as part of “debt sanctions” against Russia for the Ukrainian crisis, Gelpern (2014).

Sovereign debt defaults are prevalent as shown in the database compiled by Trebesch (2011). Figure 1 illustrates the timing of restructurings by country, from 1950 to 2010. Greece has the record with the largest sovereign debt restructuring in history in 2012, and the eurozone crisis highlighted that sovereign defaults are not the privilege of emerging markets or developing economies. Advanced economies also get into severe debt crises, as Sturzenegger and Zettelmeyer (2006) show studying ten years of crises. Reinhart and Rogoff (2013) document the historical track record of advanced economies, where debt restructuring, financial repression and high inflation were an integral part of the resolution of debt crisis. The March 2013 depositor bail-in and capital controls in Cyprus, Zenios (2014), and the Greek debt restructuring, Zettelmeyer et al. (2013), are recent episodes of financial repression in advanced economies.

Several eurozone economies are facing today fragile debt situations, see Figure 2. The average debt of eurozone countries exceeds the debt-to-GDP ratio of 60% prescribed in the Stability and Growth Pact of the European Union. At 96%, it is a drag on growth according to the thresholds established in Cecchetti et al. (2011). With several eurozone countries in crisis, proposals have emerged for debt restructuring; Gianviti et al. (2010); Paris and Wyplosz (2014).

In this paper we show how to use scenario optimization to develop risk profiles for reprofiling sovereign debt. Significant policy insights are obtained from these risk profiles. The risk management approach we propose is not restricted to the static analysis of debt sustainability, which is currently being reviewed as ineffective leading to serial defaults. Instead, we postulate plausible scenarios of economic and financial variables, and develop risk metrics that ensure high probability of debt sustainability. We adopt quantitative approaches that have been proven effective in the risk management of assets and liabilities of financial institutions. This is in line with recent trends in public debt management that have been moving beyond simulations to

Figure 1: Sixty years of foreign sovereign debt restructuring. (Figure from Das et al. (2012) with data from Trebesch (2011).)
integrate simulation and optimization models to tradeoff cost of debt with Cost-at-Risk, Balibek and Köksalan (2010); Bolder and Rubin (2011); Consiglio and Staino (2012).

We start with a discussion of debt restructuring issues in Section 2 and then discuss scenario analysis for debt re-profiling in Section 3. In Section 4 we use the stochastic programming model of Consiglio and Zenios (2014) to analyze sovereign debt rescheduling and restructuring for Cyprus and Italy, two heavily indebted eurozone countries, and in Section 5 we analyze the proposal for “debt sanctions” in the Ukrainian crisis. Conclusions are drawn in Section 6.

2 Issues in sovereign debt re-profiling

By re-profiling we mean a change of the terms of the debt obligation. We use the broader term re-profiling to include both rescheduling and restructuring of debt payments. For instance, maturities may be extended, interest rates renegotiated or nominal values written down. When creditors do not suffer losses of nominal value then we talk about debt rescheduling while debt restructuring implies haircut in nominal value. Rescheduling may involve losses in present value to creditors or it may be loss-free to allow the debtor to ride past concentration of payments due on specific years. Debt re-profiling is used so that a sovereign in crisis can continue servicing its debt, thereby preserving value for both debtor and creditors. Figure 3 illustrates the Cyprus and Italian debt structures with suggested rescheduling that smooths out peak payments.

To understand debt rescheduling and restructuring we review briefly (1) historical experiences, (2) benefits, (3) legal and policy issues, and (4) technical issues. For extensive reviews see Das et al. (2012); Wright (2012).

2.1 Historical experience

Figure 1 refers to more than 600 restructurings over the 60 year period 1950–2010; debt restructuring is widespread both across and within countries. What is remarkable in this figure is the frequency of “serial defaults” if debt restructuring in not effective. We observe countries such as Poland, Egypt or Sudan enjoying long periods of stability after restructuring, but most countries restructure in repeated succession; see, e.g., Argentina, Nicaragua or Tanzania.
We also note that debt restructurings by official creditors (Paris Club) exceed by far restructurings by private creditors: there were 447 agreements in 88 countries with official creditors and 186 restructurings in 68 countries with private creditors. The amounts involved were $768 and $545 billion, respectively. However, this balance is likely to change in the future as private creditors have been more heavily investing in sovereign debt. Data on sovereign debt defaults worldwide from a Bank of Canada database, Beers and Nadeau (2014), show that up to 50% of sovereigns had been in default at some point since 1975. However, while the amounts involved are in the hundreds of billions, the data also show that it is only a small percentage (average 1.8%) of global sovereign debt, and a minuscule proportion (average 0.6%) of gross world economic activity, that defaults. While sovereign defaults are prevalent in many countries, any debt restructuring affects a small faction of the global debt market and the world economy.

The historical experience is dissected by Wright (2012), who makes the important observation that until the 1980’s debt write-downs were barely implemented, while the majority of more recent deals include nominal value reductions. We could not find any statistics on the reductions involved, but the recent cases of Argentina and Greece show that the amounts are significant: Argentinean debt was exchanged for 30 cents to the dollar, while the Greek debt write-down is estimated at 53%. If we were to apply a 50% haircut to the sovereign debt in default from the Bank of Canada database we would get a total write down of 3.3 trillion euro for the period 1975–2014. This would provide debt relief for about half of the world sovereigns but amounts to 0.9% of the total outstanding sovereign debt, and 0.3% of gross world product.

2.2 Benefits of debt restructuring

There is certainly no benefit to the creditors if the sovereign defaults on its obligations, but at the same time a defaulting sovereign, while receiving debt relief, also faces severe penalties such as sanctions including loss of market access, litigation costs and reputation punishment, see Bulow and Rogoff (1989). Hence, debt re-profiling can be beneficial to both sides. Of course
restructuring of debt is unfavorable for the creditors, who would prefer to see the original obligation be fully serviced. Similarly, the penalties for the debtor are well-documented in the literature. What about the benefits, though?

Benefits accrue to the creditor if the expected amounts recovered from the restructured debt are higher than those to be received if the original debt would default. For the debtor the benefits from debt forgiveness are immediate, but should be weighted against the penalties incurred. A compelling case for the benefits to both sides was made by Arslanalp and Blair (2005) for the Brady Plan for Latin American countries. They found that stock markets of the countries involved appreciated by an average of 60% in real dollar terms, corresponding to $42 billion increase in shareholder value, but found no significant stock market increase for a control group of countries without Brady agreements. At the same time they found market capitalization of U.S. commercial banks with developing country loan exposure rising by $13 billion, concluding that both borrowers and lenders benefited from the debt relief. However, Das et al. (2012) point out that not all Brady deals were successful. Escalating interest rates after a grace period created a false sense of successful restructuring that unraveled when the grace period ended. This is an example of myopia in debt restructuring that could be overcome with multi-period risk models, such as those suggested by Consiglio and Zenios (2014).

2.3 Legal and policy issues

There is no universally applicable legal framework for dealing with sovereign defaults, and debtor-creditor coordination is a major obstacle in negotiating debt re-profiling. A set of principles for stable capital flows and fair debt restructuring have emerged from practical experience, PCG (2013). Those incorporate voluntary, market-based, flexible guidelines for the behavior of debtors and creditors with a view to promoting financial stability. While they are not legally binding they have been proven effective in dealing with sovereign debt restructuring. Until October 2010, the principles applied only to sovereign issuers in emerging markets, but their applicability has since been broadened to encompass all sovereign issuers, as well as cases of debt restructurings by non-sovereign entities in which the state plays a major role in influencing the legal and other key parameters of debt restructurings. Even so, they do not appear to be adequate and we see the renewed thinking in the work of Gianviti et al. (2010). Collective action clauses (CAC) are being introduced to facilitate ex post multi-creditor coordination, and state-contingent debt provisions chart ex ante plans depending on the sovereign’s capacity to service debt.

2.4 Technical issues

Assuming that coordination is achieved and legal issues resolved, the problem becomes one of specifying the restructured debt obligations and ensuring that they can be financed. Das et al. (2012) provide the key specifications needed in this case:

1. Face and market value of bonds or loans
2. Interest rate and coupon (fixed vs flexible, step-up or linked features)
3. Amortization schedule (bullet vs amortization, existence of a sinking fund)
4. Currency of denomination of the instruments (local vs foreign currency)
5. Enhancements, including embedded options or collateral
6. Legal clauses (CACs, non-default clauses, exit consents).
The optimization model of Consiglio and Zenios (2014) deals with the technical issues of debt restructuring addressing the key features of the problem: (i) collect all debt issues in a common framework and under a set of scenarios of the relevant risk factors, (ii) develop optimal financing strategies for alternative debt profiles and trades off their cost and associated risks using an optimality criterion that captures debt sustainability, (iii) can model embedded options and linked features conditioned on the scenarios, (iv) can model the currency of denomination, (v) is multi-period so that sinking funds and step-up features can be modeled.

3 Scenario analysis for debt dynamics

3.1 The scenario setting

We consider now the setting where the key economic and financial variables evolve according to some stochastic processes. We adopt a discrete set of time-stages when decisions are taken, denoted by \( T = \{0, 1, 2 \ldots t \ldots T\} \). \( t = 0 \) denotes here-and-now where all information is known, \( T \) is the risk horizon and \( t \) is the time index. At each time instance \( t \), data evolve on a scenario tree, such as the one of Figure 4, whereby problem data can take any one of a set of values indexed by the set of nodes \( N_t \). We can think of each node \( n \in N_t \) as representing possible future states of the economy at time \( t \). Not all nodes at \( t \) can be reached from every node at \( t - 1 \) and we define paths from the root node \( 0 \) to some final node in the set \( N_T \) to denote the unique way of reaching a particular node. Each of these paths is a plausible scenario. Our example has 12 scenarios, two possible states at \( t = 0 \), three possible states at \( t = 1 \) and six at \( t \). We denote by \( n \in N_t \) nodes in the sets \( N_t \) for each \( t = 0, 1, 2, \ldots T \). We denote by \( P(n) \) the set of nodes on the unique path from the root node to \( n \in N_t \), and by \( p(n) \) the unique predecessor node for \( n \), with \( p(0) \) being empty. At any given node \( n \) all information contained in its predecessor \( p(n) \) and the path \( P(n) \) is known.

With this notation we define state-dependent fiscal variables for each node \( n \in N_t \):

- **Debt**, denoted by \( D^n \) in nominal value and \( d^n \) as ratio to GDP.
- **GDP**, denoted by \( G^n \) in nominal value with growth rate \( g^n \).
- **Interest on debt**, denoted by \( r^n \). For countries under an international assistance program the interest may be fixed at the start of the program at \( r^0 \).
Government net budget, denoted by \( NB^n \) and satisfying the following relation:

\[
NB^n = GT^n - GE^n.
\] (1)

\( GT \) denotes government revenues, typically taxes, and \( GE \) denotes government expenditures excluding debt servicing costs. For states of the economy with \( NB^n > 0 \) the government is running a structural surplus that can be used to pay down debt or accumulate reserves. Conversely, \( NB^n < 0 \) denotes structural deficit that increases debt.

Stock flow adjustment of debt, denoted by \( SF^n \) in nominal value and \( sf^n \) as ratio to GDP.

For simplicity we assume that all debt is in domestic currency.

### 3.2 Scenario fiscal dynamics

The general debt stock recursive equation is as follows, see, e.g., Ley (2010):

\[
D_t = (1 + r_t)D_{t-1} - NB_t + SF_t.
\] (2)

Ley uses seignorage for the stock flow adjustment \( SF_t \). We use this variable to adjust the debt stock via restructuring or rescheduling. If a sovereign can collect seignorage, then \( SF \) must be split in a seignorage term and a debt restructuring term, and seignorage modeled separately. In the scenario setting the debt dynamics are conditioned on the nodes:

\[
D^n = (1 + r^n)D^{p(n)} - NB^n + SF^n.
\] (3)

We express the debt dynamics as a ratio to GDP to account for “snowball effect”, i.e., the improvement/deterioration of the debt situation of a country by growth/contraction of the economy. GDP growth is a significant risk factor in debt crises and the debt-to-GDP ratio stock dynamics are derived from eqn. (3):

\[
\frac{D^n}{G^n} = (1 + r^n)\frac{D^{p(n)}}{G^{p(n)}} - \frac{NB^{p(n)}}{G^n} + \frac{SF^n}{G^n}.
\] (4)

GDP growth is given by

\[
g^n = \frac{G^n - G^{p(n)}}{G^n},
\] (5)

and we express the debt dynamics in proportional growth instead of nominal value by:

\[
d^n = 1 + \frac{r^n}{1 + g^n d^{p(n)}} - nb^n + sf^n.
\] (6)

We can use this equation to derive conditions for debt sustainability and answer questions such as “How can a government maintain a constant debt-to-GDP ratio?”, or, “How to reduce debt-to-GDP ratio to a level that is sustainable?”. For instance, debt is stable if \( d^n = d^{p(n)} \) for the paths to all terminal nodes, and the primary surplus to ensure this is given by:

\[
\tilde{nb}^n = \frac{r^n - g^n d^{p(n)}}{1 + g^n d^{p(n)}} + sf^n.
\] (7)

When primary balance satisfies \( nb^n > \tilde{nb}^n \) debt will be reduced in direct proportion to the primary balance. Assuming no debt restructuring, i.e., \( sf^n = 0 \) and balanced budget, i.e., \( nb^n = 0 \), the debt is stable if growth equals effective interest rate on debt \( r^n = g^n \). Growth is suppressed during crises, requiring strictly positive primary balance to maintain constant debt-to-GDP ratio. Fiscal consolidation, in turn, exerts downward pressure on GDP exacerbating the crisis. Hence, there is a limit to how much can be achieved with surplus-generating austerity.
once a country is in crisis. That is when debt restructuring enters as a policy option. The question is then posed on which combination of primary surplus and debt restructuring will reduce debt by a proportion $\beta$ to bring it to sustainable level.

To reduce debt by $d^n = \beta d^{(n)}$, we have the following debt stock equation:

$$ nb^n = \left[ \frac{1 + r^n}{1 + g^n} - \beta \right] d^{(n)} + sf^n. \quad (8) $$

This equation provides the relationship between the two key policy variables: primary surplus achieved with austerity measures and debt restructuring. However, the use of scenarios highlights the difficulty in making deterministic statements for the policy variable. The equation provides different values for each scenario and we need to adopt some risk metric, such as the worst case value or some quintile.

3.3 Scenario debt stock dynamics

We assume that debt is financed by a sequence of decisions $x = \{x_t\}_{t=0,1,...,T}$, which include borrowing from the markets, loans of different maturities and contractual obligations from international organizations as part of an assistance program, or bi-lateral agreements with friendly governments. Without ambiguity we drop the time index from $x^n$ since each node $n$ takes values from a time-indexed set $N_t$. If we assume there are $J$ available options for funding debt, then the decision vector is given by $x^n = (x^{n1}, x^{n2}, \ldots, x^{nJ})$.

The debt dynamics can be expressed on the scenario tree, for each $t = 0, 1, \ldots, T - 1$, and each $n \in N_t$, as follows:

$$ O^n = \sum_{m \in P(n)} \sum_{j=1}^{J} x^{mj} CF^j(n, m), \quad (9) $$

where $CF^j(n, m)$ denotes cash flows at node $n$ for any debt issued at some node $m \in P(n)$. $O^0$ is the nominal debt due here-and-now. This equation accounts for the total debt to be covered at each node $n$ due to decisions made at previous time periods.

The debt stock equation takes into account obligations created by previous funding decisions and existing debt, and requires that this stock is financed from new funding decisions:

$$ \sum_{j=1}^{J} x^{nj} = D^n + O^n. \quad (10) $$

At the end of the horizon $T$ and for each $n \in N_T$ we have the cost of our decisions:

$$ C^n = D^n + O^n + \sum_{m \in P(n)} \sum_{j=1}^{J} x^{mj} P^j(n, m). \quad (11) $$

$P^j(n, m)$ is the state-dependent value of debt and it can be given in nominal value, if we follow the accounting standards for sovereign debt reporting, or by market value if we are interested in fair valuation. The problem of choice between book and market valuation is prevalent in the sovereign debt management literature, so much so that there are two approaches of computing sovereign debt haircuts; Das et al. (2012). Using market value is appropriate for debt buyback, while book value is appropriate for contractual restructuring.

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2The calculations of $CF$ are tedious. They account for coupon and principal payments, adjustable rates, contingency provisions and so on. However, all these are exogenous to the debt funding decision. Once a scenario tree is built and a path specified, standard cash-flow calculations apply, (Consiglio and Staino, 2012, eqn. 6).
3.4 The risk metric for debt

Debt-to-GDP ratio \( c^n = C^n / G^n \) is the key indicator for debt sustainability; (Sturzenegger and Zettelmeyer, 2006, p. 308-313). Debt-to-GDP is a random variable whose distribution depends on debt financing decisions, on the schedule of existing debt, on any debt restructuring, and the economic and financial random variables. It is the distribution of this random variable we wish to shape by re-profiling the debt structure. In particular, debt sustainability analysis establishes a threshold debt-to-GDP ratio below which the sovereign can service its debt without resorting to additional borrowing. For instance, 120% was the threshold used for the Greek debt restructuring, while for Cyprus the threshold was estimated at 100%, and to avoid exceeding this value with a bail-out of banks by the state, the depositors were bailed-in instead. For Italy the threshold is 120%, although this seems to be a target determined by politics than by economics. All these targets are based on a unique projection of debt-to-GDP which, in our scenario setting, could be the mean value. To assess the risk of deviation from a “sustainable” debt-to-GDP threshold we need a risk measure. We define the stress debt for each terminal state of the economy as the non-negative difference of the state-dependent debt-to-GDP ratio from its expected value. Stress debt is a signal of problems that debt-to-GDP ratio deviates from a sustainable mean, and, following Artzner et al. (1999), we formulate a coherent risk measure, which we call conditional Debt-at-Risk. Let

\[
 sd^n = c^n - E[c], \tag{12}
\]

where \( E[C] \) is the expected value of the terminal final debt-to-GDP ratio, i.e.,

\[
 E[c] = \sum_{n \in N_T} \pi_n c^n, \tag{13}
\]

where \( \pi_n \) are the probabilities of the terminal states. The conditional Debt-at-Risk (CDaR) is the expected excess debt over its Value-at-Risk at a given confidence level \( \alpha \). The equations for computing CDaR are given in the Appendix, together with the optimization model to minimize the expected cost of debt with limits on the risk metric CDaR. This is the model we use next to develop debt risk profiles for two eurozone countries.

4 Re-profiling the sovereign debt of Cyprus and Italy

We develop now risk profiles for re-profiling the sovereign debt of Cyprus and Italy, two current examples of extreme eurozone sovereign risks. Cyprus is now going through an IMF-EC-ECB program that includes capital controls, a first in the history of the eurozone, while Italy has the largest debt to GDP ratio in the Union after Greece. Figure 5 illustrates the recent trends of debt-to-GDP ratios for both countries; Italy is particularly interesting when viewed in the context of almost two centuries of data, as shown in the same figure. The current sovereign debt of Italy is the largest since the Mussolini era.

Interest rate scenarios are generated using the simulator of Bernaschi et al. (2007). with input data (i) the current term structure, (ii) the ECB official rate, and (iii) the current inflation rate, and fitted parameters for the short rate. For GDP and surplus projections we use data from the Italian treasury and the debt sustainability analysis for Cyprus from Commission (2013). Figure 6 illustrates the scenarios. The interest rate scenarios are calibrated on Italian data and, therefore, the results can be considered reliable for the Italian example. When applied to the refinancing of Cyprus debt, these scenarios are optimistic. The Cyprus yield curve is steeper with spreads over the Italian term structure ranging from 100bp (short term) to 120bp (medium term).

Both applications are tested in stylized form, and further validation is needed before the
results can be used to promote specific policies. However, key features of debt restructuring are captured and allow us to illustrate how risk profiles change with alternative debt restructuring policies and to show how sustainable policies can be identified. The results are informative of what risk profiles tell us, even if the results are tentative for the countries we analyse. All experiments are carried out at the 95% confidence level.

4.1 Cyprus

The Cyprus debt crisis is one of the most complex in the eurozone. It combines a banking crisis, caused by contagion from the Greek PSI, sovereign debt crisis made more severe by the banking crisis, and debt overhang by households and corporations. Cypriot bank recapitalization needs after the Greek PSI stood at 4.14 bil. euro, which corresponds to 23.03% of the country’s GDP. By comparison the losses to Greek banks from the Greek PSI were 11.65% of GDP, while the banks of other European countries suffered losses well below 0.5% of their country’s economy. Government finances were problematic even before the banking crisis. Since 2001, public debt exceeds the 60% Maastricht limit, with the exception of a three-year window around the entry to the Eurozone. And while in most mature economies the government debt prior to the crisis was flat or even declining, the Cyprus government accelerated spending as the crisis was developing: in 2007 the public debt of Ireland, Spain and Cyprus were, respectively, 25%, 36% and 59% of GDP. Furthermore, the debt of households and non-financial corporations stood at 288% of GDP in 2011, which is a drag on growth according to the thresholds established for OECD countries in Cecchetti et al. (2011).

A review of the crisis is given in Zenios (2013). Following losses of 4.14bil. from the Greek PSI, a subsequent due diligence by PIMCO, taking into account nonperforming loans under deteriorating economic conditions, provided significantly higher capital needs of 5.98 bil. to
8.87 bil. under a base and adverse scenario, respectively. These estimates represent 35-55% of GDP to be added to 2012 public debt of 85.6% GDP. The PIMCO estimates were criticized as excessive by a factor of two in Zenios (2014), and an investigation by NY Times raised similar concerns\(^3\). Nevertheless these estimates were used to define bank recapitalization needs. The resulting capital needs could not be covered by an IMF-ECB-EC bail-out loan to the government and Cyprus became the first eurozone country where bank depositors were bailed-in, making international headlines\(^4\).

We use the discretized debt profile in Figure 7, based on Cyprus debt position at the end of 2013. For GDP projections, in addition to the IMF scenarios from Commission (2013), we also postulate our own projections (CZ) based on research by the University of Cyprus Economic Research Center and the Central Bank of Cyprus that estimate recovery will not come before 2016, and, hence, we push out the IMF forecasts by one year; see Figure 7.

We run the optimization model for (i) original debt, (ii) rescheduled debt, and (iii) restructured debt with 20% nominal value writedown, using both the IMF and CZ projections. The results for all six cases are summarized in Figure 8. What do these results tell us about the sustainability of Cyprus debt? For the country GDP of 17 billion in 2013 we could judge that all points on the efficient frontiers drawn with the IMF projections lie below the 100% GDP level, even for the original debt structure. As debt-to-GDP ratio of 100% is considered sustainable, we may conclude that Cyprus debt is sustainable. But what about the alternative GDP projections? We note that under the CZ scenario of GDP growth we need careful debt management at the high-risk end of the frontier to ensure sustainability. Overall, though, the results of this figure appear encouraging for resolving the Cyprus debt crisis.

However, this comparison ignores the tail of the distribution. Recall that the vertical axis is the expected cost, but in a crisis we are interested in the tail and not in the mean. Ex ante there is a 5% probability that events will develop in the tail, ex post we argue that events are developing in the tail. Events in the tail are rare events, but a country going through a debt crisis is experiencing precisely these rare events. The existence of multiple equilibria is well-documented for a currency union and for crisis countries the tail is the new normal. We therefore redraw the efficient frontiers by adjusting the expected cost for its associated risk by adding \(1 \times CDaR\), thus considering the average of the tail.

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Figure 7: The Cyprus debt profile discretization and projections for GDP and primary surplus.

Figure 8: Risk profiles the Cyprus debt with and without rescheduling and restructuring, under different GDP growth projections. Points lying above the 2013 GDP are considered unsustainable.
Figure 9: The extreme risk adjusted cost of financing the Cyprus debt for different points on the efficient frontier. Points lying above the 2013 GDP level are considered unsustainable.

The results are shown in Figure 9 and some interesting observations can be made:

1. The convexity of these curves indicates that myopically reducing the short term expected cost can cause problems when entering the crisis zone.

2. Even under the IMF projections, the extreme frontier for the original debt lies above the threshold and is unsustainable. Rescheduling the debt —without a haircut— pushes the frontier below the threshold and makes it sustainable.

3. Under CZ projections, debt becomes unsustainable even with rescheduling, but restructuring with 20% writedown pushes it below the sustainability threshold.

4.2 Italy

We use the Italian discretization and GDP and surplus projections of Figure 10. We run the optimization model for (i) original debt, (ii) rescheduled debt, (iii) restructured debt with 10% nominal value reduction, and (iv) restructured debt with reduced interest payments. The results are summarized in Figure 11. Note that the frontiers for the extreme debt lie above the line of 120% GDP, for both the original and rescheduled debt. Hence no management of the current debt can be considered sustainable even with rescheduling. However, the frontier for the restructured debt with 10% reduction of nominal value is below the sustainability threshold. Debt is also sustainable when the interest rate is adjusted downwards. Adjusting the Italian debt refinancing rate could be done, for instance, with the issue of European bonds —this is a topic of intense political discussions and disagreements— or by selective purchase of Italian bonds by the ECB —another policy option that is facing political objections. Leaving the political objections aside, using our models we could identify the proportional reduction of refinancing rates that would make the Italian debt sustainable. Iteratively adjusting interest payments downwards by 10% to 90% we identified that reduction of 70–90% pushes the extreme frontier below the threshold. Hence, the policy options promoted by ECB or the common assumption of debt could make the Italian sovereign debt sustainable.
Figure 10: The Italian debt profile discretization with rescheduling and restructuring with 10% reduction of nominal value, and projections for GDP growth and primary surplus.

Figure 11: The extreme risk adjusted cost of financing the Italian debt for different points on the efficient frontier. Points lying above the 120% GDP level are considered unsustainable.
5 Debt sanctions in the Ukrainian crisis

In a recent policy brief published by the Peterson Institute for International Economics a suggestion was made by Gelpern (2014) to adopt “debt sanctions” against Russia in the Ukrainian crisis. The escalating crisis in Ukraine has prompted the United States and Europe to impose the toughest economic sanctions against Russia since the end of the Cold War and to prepare for even tougher ones. Political instability and military conflict are straining Ukrainian finances and despite international support, the government faces shrinking revenues, rising costs, and a spike in foreign debt payments over the next two years. The author suggests a measure to free $3 billion for Ukraine: The United Kingdom can refuse to enforce English-law contracts for the money Russia lent former Ukrainian president Viktor Yanukovych. Ukraine could then walk away from this debt without any legal and market consequences.

The author argues that such debt sanctions would reinforce the financial, energy, and trade sanctions under way, and by themselves would represent an appropriately targeted response to the conflict. They would be in line with international law and legislative precedent in the United Kingdom and Europe, most recently used for Iraq, and would, uniquely among sanctions tools, offer financial relief for Ukraine.

Without endorsing the legal and political arguments in favor of this proposal, we show here that the financial relief would be substantial. The Ukrainian debt profile, with and without the sanctions, is shown in Figure 12. In the same figure we plot the risk profiles and we observe significant improvement in the efficient frontier with debt sanctions in place. The improvement is significant as the debt restructuring is coming early on and writes down more than 30% of the 2015 payment. The results are likely to be even more favorable for Ukraine than our simulations indicate, as we use very low yield scenarios for the Ukrainian debt and assume modest growth and balanced government finances. Under more adverse conditions for financing debt, economic growth and government finances—that should be expect given the political and military situation—the effect of the debt sanctions will be even more favorable for the country.

6 Conclusions

There is widespread acceptance that debt restructuring has been too little and too late in recent crises failing to re-establish market access in a durable way. We have illustrated in this paper how an approach that combines scenario analysis of a sovereign’s debt, with scenario optimization, can be used to develop risk profiles for alternative debt structures. Debt profiles that are unsustainable can be identified, with high probability, and alternative structures proposed that restore sustainability. The methodology proposed in this paper is providing a useful tool of analysis. However, more detailed calibrations for each country would be required, to turn the findings of this paper into concrete policy actions.

The testing carried out for Cyprus, Italy and Ukraine allows us to draw some interesting, even if tentative, conclusions. For Cyprus, debt sustainability hinges crucially on current IMF projections about GDP growth, and even a small deviation from these projections pushes the country’s debt into unsustainable territory. We have shown how alternative debt structures could make the debt sustainable. For Italy, our analysis provides evidence of debt unsustainability. Given the size and significance of the Italian economy in the eurozone our results beg for further and more detailed analysis. Our analysis also reveals that common assumption of debt by eurozone member states could play a significant role in restoring debt sustainability for Italy. Finally, we see how a recent policy proposal to impose debt sanctions against Russia for the Ukrainian crisis could have significant and positive financial impact for Ukraine. This, of course, does not imply endorsement of the proposal to impose debt sanctions but it shows that such sanctions will have the intended consequences in helping Ukrainian government finances.
Figure 12: Risk profiles of the Ukraine debt with and without debt sanctions.
APPENDIX. The optimization model

The conditional Debt-at-Risk is obtained, following Rockafellar and Uryasev (2000), from the set of equations:

\[
\begin{align*}
\text{CDaR} &= \zeta + \frac{1}{1-\alpha} \sum_{n \in \mathcal{N}_T} \pi^n y^n_+, \\
y^n_+ &\geq sd^n - \zeta, \\
y^n_+ &\geq 0,
\end{align*}
\]

where \( y^n_+ \) is a dummy variable denoting the non-negative values of debt in excess of \( \zeta \), and \( \zeta \) is the Value-at-Risk of the debt at the \( \alpha \) confidence level. With this definition we write below the linear program to minimize expected cost subject to a limit \( \rho \) on CDaR. Full specification is given in Consiglio and Zenios (2014).

Minimize \( \mathbb{E}[c] \) \hspace{1cm} (17)

s.t. \hspace{1cm} (18)

\[
O^n = \sum_{m \in \mathcal{P}(n)} \sum_{j=1}^J x^{mj} CF^j(n,m) \text{ for all } n \in \mathcal{N}_t, t \in \mathcal{T} \setminus 0, \hspace{1cm} (19)
\]

\[
D^n + O^n = \sum_{j=1}^J x^{nj}, \text{ for all } n \in \mathcal{N}, \hspace{1cm} (20)
\]

\[
C^n = D^n + O^n + \sum_{m \in \mathcal{P}(n)} \sum_{j=1}^J x^{mj} P^j(n,m), \text{ for all } n \in \mathcal{N}_T, \hspace{1cm} (21)
\]

\[
sd^n = c^n - \mathbb{E}[c], \text{ for all } n \in \mathcal{N}_T, \hspace{1cm} (22)
\]

\[
y^n_+ \geq sd^n - \zeta, \text{ for all } n \in \mathcal{N}_T, \hspace{1cm} (23)
\]

\[
\zeta + \frac{1}{1-\alpha} \sum_{n \in \mathcal{N}_T} \pi^n y^n_+ \leq \rho, \hspace{1cm} (24)
\]

\[
x^n, O^n, c^n, y^n_+ \geq 0, \text{ for all } n \in \mathcal{N}. \hspace{1cm} (25)
\]

Solving the model for different bounds on CDaR we trace an efficient frontier and from that we can evaluate different policies and identify those that are sustainable at the \( \alpha \) confidence level.
References


