Credit Derivatives and Sovereign Debt Crises

Goderis, Benedikt and Wagner, Wolf

University of Oxford

19 March 2009

Credit Derivatives and Sovereign Debt Crises*

Benedikt Goderis† and Wolf Wagner‡

Abstract

Credit derivatives allow for buying protection on corporate debt, but also on sovereign debt. In this paper we examine the implications for sovereign debt crises. We show that the availability of credit protection lowers ex-ante debtor moral hazard by allowing a bondholder to improve his bargaining position in negotiations with the sovereign, thus forcing the sovereign to internalize more of the costs of a crisis. When bondholders use credit protection strategically, we additionally find that credit derivatives do not hinder an efficient resolution of crises. Crisis resolution may even be improved by facilitating conditionality. When protection is not chosen strategically, however, credit protection may also be detrimental to crisis resolution by making restructuring more difficult. In either case we identify a role for government policy as bondholders' choice of protection is not necessarily socially efficient.

Keywords: credit derivatives, sovereign debt crisis, moral hazard

JEL classification: F33, F34, G14

*We thank Stefan Arping, Jonathan Eaton, Harry Huizinga, Jose Scheinkman, Eva Terberger, and participants at the Princeton-Cambridge conference at the Bendheim Center of Finance, the CFS conference on Credit Risk Transfer in Frankfurt, the Deutsche Bundesbank, the Tor Vergata conference and the European Meetings of the Econometrics Society for helpful comments. We also thank Pierre-Hugues Verdier for discussions on the legal issues posed by sovereign credit derivatives.

†Department of Economics, University of Oxford, Email: Benedikt.Goderis@economics.ox.ac.uk.

‡CentER, European Banking Center, TILEC, and Department of Economics, Tilburg University. Email: wagner@uvt.nl.

1 Introduction

The wave of defaults in countries such as Argentina, Mexico and Russia has led to a renewed interest in sovereign debt crises in recent years. The resolution of these crises is often difficult because in the absence of supranational bankruptcy procedures, there is no clear and orderly mechanism on how to deal with them. In principal, this absence could be compensated for by writing appropriate contracts ex-ante. However, countries seem only to a very limited extent able to do so. Because of these, and other issues, many observers consider the current arrangements for resolving sovereign crises as inefficient.[1]

The arrival of *credit derivatives* has added a new element to sovereign debt financing. Broadly speaking, credit derivatives are financial instruments that allow creditors to insure against losses on their debt.[2] Their use is spreading rapidly: the total outstanding volume of credit derivatives had reached U$ 54.6 trillion during 2008 and gross market values have even been increasing during the crisis period.[3] While most protection is traded for corporates, a significant part of the market covers sovereign debt, allowing, among others, to buy protection on countries such as Brazil, Mexico, Russia, Colombia, Venezuela, South Africa and the Philippines.[4]

Credit derivatives matter for sovereign debt crises because they change a bondholder's incentives to participate in a debt restructuring. A widespread concern is that they make restructuring more difficult since "credit derivatives may provide investors with incentives

[1] Several proposals for their improvement are currently under discussion. For an overview, see Eichengreen (2003).

[2] In their most common form, the *credit default swap*, they work as follows: a bondholder makes periodic insurance payments to a protection seller; in return, when a default occurs, the protection seller makes a compensation payment to the bondholder. For a detailed overview of the various forms of credit derivatives, see Kiff, Michaud and Mitchell (2003).

[3] See BIS (2008) and ISDA (2008).

[4] Credit derivatives have been partly blamed for causing the ongoing subprime crisis because they reduce banks' incentives to monitor borrowers. This issue is arguably less of a concern in the sovereign context where bank monitoring is limited. For discussions of the policy issues raised specifically by sovereign credit derivatives see Ranciere (2001), Packer and Suthiphongchai (2003), Verdier (2004) and Federal Reserve Bank of New York (2005).

to hold out in the hope of forcing a default, thereby triggering a repayment under the terms of the derivative contract"[5] and are thus harmful for the resolution of crises. An alternative view would be that credit derivatives are beneficial for crisis resolution since they provide a new tool to structure debt relationships. In particular, credit derivatives have been praised for their flexibility since they allow a bondholder to choose the extent and duration of protection he buys. Which of these views is likely to prevail, of course, ultimately depends on how a bondholder will use protection.

This paper aims at understanding some of the consequences of the availability of credit protection for sovereign debt crises. We present a simple model of sovereign debt financing. In this model, the optimal ex-post resolution of a crisis depends on a country's productivity. While for sufficiently high productivity it is efficient to restructure debt, a default is preferable when countries are unproductive in order to avoid a continued inefficient use of resources. The equilibrium crisis resolution which arises in the absence of protection is efficient, except for private costs which a country suffers in a default. These costs create a bias towards default, i.e., there are situations where a default occurs although restructuring would be efficient. From an ex-ante point of view, however, crisis resolution is always inefficient. This is because due to sovereign immunity the sovereign can renegotiate down the debt claim in a crisis. This reduces the crisis costs borne by the country and causes ex-ante debtor moral hazard in crisis avoidance.

We first study the impact of credit protection chosen by a bondholder for strategic reasons, that is in order to influence his position in a potential crisis.[6] Contrary to the voiced concern, we find that credit protection does not undermine the ability to achieve restructuring. It is true that if the bondholder would sufficiently insure his bonds, restruc-

[5] Anne Krueger, the deputy managing director of the IMF, in a recent speech (Krueger, 2002).

[6] For dispersed debt, this requires the existence of bondholders that have potential influence over the overall restructuring process. For instance, for restructuring through the London Club (which deals with commercial bank debt) these may be members of the *steering committee* which handles negotiations with the sovereign. For non-commercial private debt, large creditors have an influence over the restructuring process through the consultation period which typically precedes the public exchange offer (this may be either formally, as notably in Uruguay and the Dominican Republic in recent years, or informally).

turing would indeed be impossible as the bondholder then always prefers default in order to trigger the protection. However, choosing such protection is not in the bondholder's interest. The reason is that the bondholder would then exercise protection in every crisis, making the purchase of protection expensive.[7] Still, there are welfare ramifications as the bondholder insures partially in order to improve the restructuring offer the sovereign has to make. This has the effect of reducing ex-ante debtor moral hazard by making crises more costly for the country.[8]

We further study situations in which the strategic bondholder has inferior knowledge about the repayment ability of the country. In the absence of protection, this has the consequence that crisis resolution cannot be conditional on the country's productivity, as the sovereign always has an incentive to pretend to have high productivity. We show that there is a role for credit protection in restoring conditionality, which arises because it can alter the bondholder's incentives to litigate against the sovereign in a default.

Next we analyze the case where protection is bought non-strategically, that is without taking into account its potential effect on the resolution of crisis. This case is of interest if there are many bondholders, of which each is not large enough to perceive an influence over the restructuring outcome. In this case, multiple equilibria arise. Credit protection is still beneficial by lowering ex-ante moral hazard but may now be detrimental by causing inefficient defaults ex-post since bondholders may buy more protection than what is socially optimal. However, if creditors can coordinate on equilibria which are not pareto-dominated, negative effects of credit protection can always be fully avoided.

[7] The seller of protection is assumed not to enter the (pre-default) renegotiation between the sovereign and the bondholders. This is typically a contractual requirement of CDS contracts (see INSOL, 2006).

[8] This argument is related to studies that argue against policy interventions that make restructuring less costly for sovereigns. Dooley (2000) and Shleifer (2003), for example, have shown that such interventions increase sovereigns' incentives to repudiate their debt. Given that creditors have little enforcement power, they will be more reluctant to lend. This then leads to higher costs of borrowing for sovereigns and a reduction in lending to emerging market countries (see also Eichengreen, 2003, and Bolton and Jeanne, 2005).

Summing up, our results broadly suggest that credit derivatives are beneficial for sovereign debt financing from an ex-ante perspective. This is because protection allows a bondholder to improve his outside option in a crisis. The increased outside option neutralizes the renegotiation problem which arises from sovereign immunity and reduces debtor moral hazard. The desirability of credit derivatives from an ex-post crisis resolution perspective is ambiguous and depends crucially on whether protection is bought strategically or not. In the latter case, there is a strong role for governments and international organization in coordinating on desirable equilibria that avoid that "too much" protection is bought.

However, even in the case where protection is chosen strategically, equilibrium protection is not always socially optimal in terms of crisis resolution. In particular, the excessive defaults that arise from countries' private costs could be fully avoided by buying protection with a sufficiently long maturity. Intuitively, this is because under such protection the bondholder is *more* inclined to accept a restructuring offer, as he is then also protected against situations where the country cannot make the repayments on the restructured bond in the future. This suggests that if debtor countries and/or supranational institutions believe that the current restructuring procedure exhibits a bias towards delivering defaults, they can correct this bias through the appropriate use of credit derivatives. This may for example take the form of protection that is attached to the initial bond and guaranteed by a third party.

Credit derivatives may thus have a role to play in the ongoing discussion on how to improve the sovereign restructuring process. In fact, by increasing the negotiation power of creditors in a crisis, they work in a similar way as proposals that aim at enhancing creditor power, such as a bankruptcy court for sovereign debt (Krueger, 2002, and Bolton and Jeanne, 2005) or measures to increase the contractibility of debtor's payoffs (Tirole, 2002, and Ghosal and Miller, 2003). Moreover, their ability to reduce informational problems between lenders and borrowers may reduce the need for institutions that aggregate information, such as the International Monetary Fund (IMF) (as analyzed in Spiegel, 2005). Furthermore, because they allow for a private sector solution for inefficient defaults, they

may be an alternative to IMF-bailouts or insurance funds (as suggested by Jeanne, 2001).

The remainder of this paper is organized as follows. The next section briefly reviews related literature on credit derivatives. Section 3 presents the basic model in the absence of protection. Section 4 studies the impact of protection that is strategically chosen. Section 5 extends the analysis to situations where the strategic bondholder is not fully informed about the repayment ability of the country. Section 6 first analyzes the case where protection is not chosen strategically. It also discusses several extensions, such as allowing for coordination problem among bondholders in a restructuring process and for bailouts by the IMF. The final section concludes.

2 Credit Derivatives in the Literature

Many contributions to the burgeoning literature on credit derivatives have focused on their impact on the borrower-lender relationship. Duffee and Zhou (2001), for example, show how the flexibility of credit derivative instruments can be used to mitigate adverse selection problems. Morrison (2005) has shown that credit derivative markets can reduce banks' incentives to monitor, which can erode the certification value of bank loans. In Chiesa (2008) bank monitoring is improved by credit derivatives, as they allow for transferring the informationally least sensitive part of the credit risk.

The point of departure for our paper is Arping (2005), who has shown in the context of corporate debt that credit protection can improve lenders' outside option and thus exercise a disciplining effect on borrowers. Our paper deviates from Arping's in several respects. For one, we additionally consider the impact of credit protection on the resolution of a crisis and how this trades off with the bondholder's desire to increase his outside option. While in Arping's model default is always inefficient and never occurs in equilibrium, in our model the efficiency of crisis resolution varies with the country's productivity and equilibrium credit protection may alter crisis resolution.[9]

[9] One consequence of this, for example, is that (in contrast to Arping) debtor moral hazard may actually increase after the introduction of credit protection because credit protection is used to improve crisis

Furthermore, we also allow for situations in which lenders are imperfectly informed about the borrower's repayment abilities. We also acknowledge that it is relatively costly for lenders to legally enforce any claims when a sovereign defaults. This friction turns out to play an important role for the impact of credit protection, in particular it allows protection to reduce inefficiencies in crisis resolution stemming from lender's inferior information. Moreover, consistent with the nature of credit derivatives markets we analyze protection that is chosen anonymously, while Arping's paper mostly focuses on protection that is part of the contract between lenders and borrowers. As a consequence, the equilibrium level of protection is not necessarily socially efficient in our paper, and we consider the role for government policy to improve efficiency.[10] Finally, we also consider protection that is not chosen strategically.

Only a few papers have so far focused on sovereign debt markets. General overviews are provided in Ranciere (2001), Packer and Suthiphongchai (2003), and Federal Reserve Bank of New York (2005). Verdier (2004) provides an extensive analysis of the legal aspects, which played a large role in recent settlements of protection. Pan and Singleton (2005) and Cossin and Jung (2005) use sovereign credit derivatives to extract market expectations about sovereign risk.

3 A Simple Model of Sovereign Debt Restructuring in the Absence of Credit Protection

Consider a sovereign country and a bondholder, who are both risk-neutral and maximize their expected payoffs. There are three periods and there is no discounting. In period 0, the sovereign borrows funds from the bondholder and invests them fully in a project that generates output f in period 2. Repayment takes place in period 1 and in period 2. The

resolution (see, for example, Proposition 6).

[10] For most parts our analysis also applies to corporate debt. However, we have chosen to focus our exposition on sovereigns because due to sovereign immunity the renegotiation problem is presumably more severe in this context.

total repayment is normalized to one.

At the beginning of period 1, the sovereign finds himself without any funds. However, he can undertake an effort to raise the funds necessary for full repayment. Raising these funds incurs costs a, for example, because it increases the domestic tax burden. The costs are drawn from an interval $[a_{\min}, a_{\max}]$ with a density $\phi(a)$ that has full support on this interval (i.e., $\phi(a) > 0$ for $a \in [a_{\min}, a_{\max}]$). The costs are known to the sovereign when he makes his effort decision. If the sovereign decides to exert effort, the crisis can be avoided, which brings benefits $b > 0$ to the country. If the sovereign does not exert the effort, the funds remain zero and he faces default.

In order to avoid default, he can make a *take-it-or-leave-it* restructuring offer to the bondholder.[11,12] A restructuring offer promises a period 2 return in exchange for the total outstanding debt. If the bondholder accepts (i.e., the offer is successful), production in the project continues, yielding output f in period 2. If the bondholder rejects, the country is in default (equivalently, in such cases the sovereign could default outright rather than making a restructuring offer).[13] The project can then no longer be continued (for example, because it requires foreign resources which are unavailable in a default). The bondholder then obtains the liquidation value of the project k, with $k < 1$ (in Section 5.1 we consider that the bondholder has to litigate in order to obtain k).[14] The disruption of the project

[11] Such *pre-default* restructuring has become common since the mid 1990s.

[12] We focus here on the extreme case where the sovereign has all the bargaining power. For our arguments to hold, however, it is only needed that the sovereign has some bargaining power.

[13] Our model abstracts from strategic 'holdouts'. In a world of multiple creditors, this presumes that there is some form of creditor coordination such as through collection action clauses (CAC), creditor committees, or restructuring via the London or the Paris Club (recent restructuring experiences also suggest that the holdout problem is perhaps overstated; see for example De Brun and Della Mea (2003) who show that in the Uruguay case restructuring was implemented within a short time on debt which did not include CACs).

[14] The assumption that the bondholder obtains the liquidation value in full may seem extreme; however, our main results hold also when the bondholder can only secure a fraction of the country's funds. Furthermore, it should be noted that the possibilities for creditors to enforce their claims against sovereigns have improved substantially recently as bondholders can now threaten to disrupt future financing: in 2000 Elliott Associates succeeded in stopping the distribution of Peru's payments to new bondholders, forcing

causes additional private default costs $c > 0$ to the country, such as from lower domestic consumption.[15]

3.1 Sovereign Debt Crises and Welfare

In this section we discuss the welfare aspects of our model. The formal derivations can be found in Appendix 1.

In recent models of sovereign debt financing, it has become standard to define welfare in terms of *ex-post efficiency* and *ex-ante efficiency*[16]. Ex-post efficiency relates to the extent to which sovereign debt crises are efficiently resolved once they occur. The severe output losses during recent crisis episodes are often perceived as inefficient and several proposals have been put forward on how to facilitate a less costly resolution of debt crises.[17] These proposals are based on the notion that the output losses represent a deadweight loss. Efficiency in that view thus requires that, once a crisis occurs, the joint payoffs of sovereign and bondholder are maximized. In our model, this implies that there is restructuring whenever the output of the project is at least its liquidation value net of default costs (i.e., $f \geq k - c$), and default otherwise.[18] Appendix 1 shows formally that this maximizes ex-post welfare.[19] Thus, we can evaluate the *ex-post* welfare implications of credit protection

Peru to pay Elliott's pre-Brady loans in full.

[15] More broadly, these default costs can also be interpreted as being due to reputational losses (e.g., Eaton and Gersovitz, 1981) or sanctions (e.g., Bulow and Rogoff, 1989). Note that these costs are on top of the benefits b that are lost if the country undergoes a crisis *per se*. The latter are costs such as from negotiating with the bondholders and/or restructuring the bond, or may be costs due to a (temporary) exclusion from capital markets during negotiations.

[16] See for example Dooley (2000), Gai et al. (2004) and Ghosal and Miller (2003).

[17] The two most important proposals in recent years have been the Sovereign Debt Restructuring Mechanism (SDRM) advocated by the IMF and the use of collective action clauses, recommended by the US Treasury. While the SDRM has not been implemented, the use of collective action clauses is now standard in international sovereign bond markets (IMF, 2006, Gelpern and Gulati, forthcoming 2007).

[18] An alternative interpretation of the optimality of default when output is low is that the country can carry out a reform which increases the productivity of the project but may choose not to do so under restructuring because of the outstanding debt (debt overhang problem).

[19] The distribution of the payoffs between sovereign and bondholder does not affect ex-post efficiency as

by looking at its effect on the joint payoffs of sovereign and bondholder in a crisis.

Ex-ante efficiency relates to whether sovereigns have sufficient incentives to avoid debt crises and to repay their debt. If crises are not costly for sovereigns, a moral hazard problem arises in that sovereigns have no incentive to undertake the effort it takes to prevent debt crises from occurring in the first place. In this view, the costs that sovereigns incur during debt crises are necessary to provide sovereigns with an incentive to repay their debt (see, e.g., Dooley 2000). In our analysis below, we follow Dooley (2000) and others (Gai et al. (2004) and Ghosal and Miller (2003)) and evaluate the ex-ante welfare implications of credit protection by looking at its effect on the sovereign's payoff in a crisis. Appendix 1 shows that welfare in fact decreases with the sovereign's payoff in a crisis.

The reason is the following. Since a share of the crisis costs is borne by the bondholder, the sovereign has a tendency to underprovide effort from a welfare perspective, that is there are effort costs a for which the sovereign does not undertake effort, even if it would be socially optimal to do so. If the sovereign is now made to participate more in the costs of a crisis, his crisis payoffs relative to the payoffs if there is no crisis decline. This improves his incentives to exert effort. Welfare increases as a result, since there are then more states of the world (that is, more realizations of effort costs a) for which effort is undertaken.

Summarizing, welfare in our model increases with the joint payoffs of sovereign and bondholder in a crisis and decreases with the sovereign's payoff in a crisis.[20] Note that, hence, in order to study welfare in our setup, it entirely suffices to determine the payoffs to both parties in a crisis. The reason is that ex-post payoffs, besides obviously determining ex-post efficiency, also determine ex-ante efficiency because the latter depend on the sovereign's payoff in a crisis. Thus, in the following we directly study crisis outcomes, that is situations where the sovereign decides not to undertake effort.

---

in competitive bond markets the sovereign participates fully in the bondholder's losses in a crisis through a higher interest rate.

[20] The arising potential friction between ex-post efficiency of crisis resolution and ex-ante incentives is now central to the sovereign restructuring debate. See Bolton and Jeanne (2005) for a recent example.

3.2 Equilibrium Crisis Resolution

Table 1, column 'No protection', summarizes for a restructuring offer of r the crisis payoffs (that is, when the sovereign does not exert effort) for the sovereign and the bondholder. Because there is no discounting, we can ignore whether payments are received in period 1 or 2. When the offer is accepted, the bondholder's payoff is r, or f whenever the project's output falls short of r. The sovereign obtains whatever there may be left of output after having paid the bondholder: $\max(f-r,0)$. When the offer is rejected, the bondholder obtains the liquidation value k and the sovereign suffers default costs $-c$.

Table 1: Payoffs for a Restructuring Offer r

		No protection	Short protection q	Long protection q
Sovereign	Accept	$\max(f-r,0)$	$\max(f-r,0)$	$\max(f-r,0)$
	Reject	$-c$	$-c$	$-c$
Bondholder	Accept	$\min(r,f)$	$\min(r,f)$	if $r \leq f : r$ if $r > f : q+(1-q)f$
	Reject	k	$q+(1-q)k$	$q+(1-q)k$

Proposition 1 derives the equilibrium outcome of the restructuring process, which is also summarized in Table 2 (column 'No protection').

Proposition 1 *In the absence of protection there is restructuring with $r=k$ whenever $f \geq k$ and default otherwise.*

Proof. *Note first that the sovereign's payoff under restructuring ($\max(f-r,0) \geq 0$) is larger than under default ($-c<0$). Thus the sovereign always prefers restructuring. Given that the bondholder's payoff under default is k, the sovereign needs to credibly promise a return of k to obtain restructuring. When $f \geq k$, this is feasible by offering $r=k$ and hence there is restructuring with $r=k$. When $f<k$, the sovereign cannot credibly promise a return which is at least equal to the bondholder's payoff under default (in particular, $r>f$*

is not credible; the bondholder realizes then that his payoff will only be f). Any restructuring offer is hence rejected and there is default. ■

Table 2: Equilibrium Crisis Resolution (R=Restructuring, D=Default)

	No protection		Protection	
	$f \geq k$	$f < k$	$f \geq k$	$f < k$
Resolution of Crisis	R with $r = k$	D	R with $r = f$	D
Sovereign's Payoff	$f - k$	$-c$	0	$-c$
Bondholder's Payoff	k	k	f	k

Crisis resolution is thus efficient, except when we have $k > f > k - c$. In this case, there is default (as $f < k$) but the sovereign's and bondholder's joint payoff would be higher under restructuring (as $f > k - c$). The reason why the sovereign cannot achieve restructuring in this case (even though he would like to because of private costs c) is that he cannot credibly promise a return at least equal to the bondholder's outside option k. The proposition also shows that moral hazard in crisis avoidance is not minimized because the sovereign can keep $f - r = f - k \geq 0$ when there is restructuring, even though the bondholder is not fully repaid ($r = k < 1$).[21] This is because, once in a crisis, the sovereign renegotiates down the bondholder's claim according to the bondholder's outside option k (in contrast, when there is no crisis, the sovereign does not find it optimal to renegotiate because of the costs of doing so, see Appendix 1).

4 Credit Protection

We now allow the bondholder to buy protection on his debt. As with standard credit derivatives (such as credit default swaps), this protection insures the bondholder against

[21] Our analysis focuses on the *moral hazard* aspect of sovereign debt crisis and thus ignores liquidity crises. These can be avoided in our setup because the sovereign can promise future output to bondholders (for a recent synthesis of both views, see Powell and Arozamena, 2003).

a so-called *credit event*. A credit event is defined as a situation where the debtor no longer makes the agreed repayments to the bondholder and where the bondholder has not voluntarily accepted a change in the repayment terms. Since the restructuring offer in our model is accepted on a voluntary basis, it does not qualify as a credit event.[22] However, when the debtor does not deliver on the restructured debt, a credit event may still be triggered, if the non-delivery falls within the period for which protection has been bought.

When a credit event occurs, the bondholder is paid $q \cdot 1 = q$ by the protection seller, where q $(0 \leq q \leq 1)$ is the fraction of debt on which the bondholder buys protection. Interpreting the debt as consisting of a (large) number of bonds, we can also refer to q as the fraction of insured bonds. In return, the bondholder delivers the insured bonds to the protection seller (such *physical settlement* is predominant for sovereign credit derivatives, see Ranciere, 2001). We consider two different maturities of credit protection. Under *short (maturity) protection*, the bondholder is only insured throughout period 1, while under *long (maturity) protection* the bondholder is also insured throughout period 2. Thus, in contrast to short protection, long protection also insures the bondholder against non-delivery on the restructured bonds.[23]

We consider protection that is bought once the crisis has materialized (although, as will become clear later, this assumption is inessential). We assume that the protection seller is a risk neutral agent who behaves competitively. This implies that the price of protection, $p(q)$, equals the expected payments the protection seller has to make to the bondholder, net of the value of the restructured bonds he may obtain. Note, furthermore, that the protection seller can be ignored in the welfare analysis, as he breaks even on average.

We assume that the protection seller does not renegotiate his position before default (for example, the protection seller could offer payments to the bondholder in order to make him

[22] This is consistent with the ruling of the Southern District of New York that Argentina's 2001 voluntary exchange offer did not constitute a credit event (Verdier, 2004).

[23] Such differences in maturities proved relevant during the Argentinian default: on November 1, 2001, Argentina made a voluntary exchange offer, which was announced as successful on November 19. On December 24, Argentina suspended payments on its debt, which triggered many default swaps. However, some protection had expired between those dates (Verdier, 2004).

accept a restructuring offer). This is a typical requirement of CDS contracts. The INSOL (2006) documents that "A protection seller is also usually unable, under the terms of a CDS, to direct a protection buyer during a restructuring as to how to exercise its rights in respect of any obligation of the debtor (before any physical settlement takes place)." There are also practical obstacles to renegotiation. A single protection seller would lack the incentives (and probably also the means) to compensate the sovereign or the bondholder in order to avoid default. A successful renegotiation for protection sellers (i.e., a renegotiation that avoids default) would hence require for their actions to be coordinated. However, credit derivatives are traded in decentralized markets and the ultimate sellers of protection are likely to be widely dispersed (even though the bondholder may originally buy protection from a single source, this source may not hold on to his position and make offsetting trades in CDS). Moreover, due to the anonymous nature of CDS markets, the ultimate holders of protection are not easily identifiable.

Columns 2 and 3 in Table 1 summarize the crisis payoffs for a level q of either short or long protection. For comparability with the no protection case, the table presents *gross* payoffs for the bondholder, which do not include the price of protection p (the protection price, however, does not affect the resolution process as it is sunk at the time of the restructuring offer). There are two changes relative to the situation without protection. First, under both short and long protection the bondholder's payoff in a default is now $q + (1 - q)k$, which is larger than k when $q > 0$. This is because default constitutes a credit event, allowing the bondholder to secure fully the nominal repayment on his uninsured bonds ($q \cdot 1$). On the uninsured bonds, the bondholder receives their share in the liquidation value ($(1 - q)k$) (the remainder of the liquidation value (qk) is received by the protection seller as he obtains the insured bonds from the bondholder). Second, under long protection the bondholder's payoff if the sovereign does not deliver on the restructured bond is $q + (1 - q)f$, as he can then still exercise protection in period 2.

Proposition 2 derives the equilibrium crisis resolution which arises from the bondholder's optimal choice of protection (also summarized in Table 2). Note that since the

bondholder is risk neutral, he only buys protection for strategic reasons, that is in order to improve his outside option in negotiations with the sovereign.

Proposition 2 *The introduction of protection does not change crisis resolution but reduces moral hazard in crisis avoidance; in particular there is restructuring with $r = f$ whenever $f \geq k$ and default otherwise.*

Proof. *Suppose that the bondholder buys an amount of short protection q^* such that his payoff under default becomes $q^* + (1-q^*)k = f$ (i.e., $q^* = (f-k)/(1-k)$) when $f \geq k$ and buys no protection ($q^* = 0$) otherwise. When $f \geq k$, there is thus acceptance with $r = q^* + (1-q^*)k = f$, as the sovereign still always prefers acceptance and has to promise at least the bondholder's default payoff to obtain restructuring. The bondholder's net payoff (net of the price of protection) is then f since the price of protection is zero as protection is not exercised. When $f < k$, Proposition 1 can be readily applied as $q^* = 0$, implying that there is rejection and the bondholder's payoff is then k. It follows that for each f the bondholder obtains the maximum available payoff: f when $f \geq k$ and k when $f < k$. q^* is therefore the bondholder's optimal protection (other forms of protection may at most give the same payoff). Since for q^* there is restructuring when $f \geq k$ and default otherwise, we have that equilibrium crisis resolution is unchanged. However, the sovereign's payoff when $f \geq k$ is now zero (when $f < k$ it is still $-c$). Hence, for $f > k$ moral hazard is lowered.* ■

Thus, even though credit protection can potentially reduce the efficiency of restructuring (as protection may raise the bondholder's outside option, $q + (1-q)k$, beyond f even when $f > k$ and thus lead to inefficient defaults), it is not in the bondholder's interest to choose such levels of protection. This is because, since the protection seller breaks even, the bondholder's *net* payoff (i.e., net of the price of protection) always equals the *payout of* the sovereign to both bondholder and protection seller in a crisis. In particular, the bondholder fully internalizes a lower payoff for the protection seller via a higher price of protection ex-ante. Obtaining protection which causes default when $f > k$ is therefore not optimal, as the total payout the sovereign makes in a default is only k, while the bond-

holder through protection which does not lead to default can extract up to f from the sovereign. Hence, even though the bondholder's gross payoff in a default may be larger than under restructuring (for $q = 1$ the bondholder could even fully recover his debt), the bondholder's net payoff is smaller.

As the proposition has shown, the availability of protection is even beneficial for welfare because it improves ex-ante debtor incentives. This is because it allows the bondholder to increase his outside option in restructuring negotiations and thus reduces the sovereign's payoff in a crisis.[24] The question arises as to whether the bondholder's choice of protection is even welfare optimal. As the next proposition shows, this is not the case from the perspective of ex-post crisis resolution.

Proposition 3 *The bondholder's choice of protection is not always socially optimal in terms of crisis resolution. Crisis resolution can then be improved through appropriate short and long protection; however, this comes at the cost of increased moral hazard.*

Proof. *Suppose that when $f < 1$ the bondholder holds long protection with $q_{LP} = c/(1-f)$ and short protection with $q_{SP} = -c/(1-f)$ (note that although $q_{SP} < 0$, $q_{SP} + q_{LP} \geq 0$ is still fulfilled). As $q_{LP} = -q_{SP}$, the bondholder is not protected in period 1 (effectively, there is now protection which only starts in period 2). Compared to the case of no protection, the bondholder's payoff has only changed in that under restructuring he now obtains $q_{LP} + (1 - q_{LP})f = f + c$ when $r > f$. Analogous to Proposition 1, it follows that there is restructuring with $r = k$ whenever $f + c \geq k$ and default otherwise, implying that crisis resolution is now efficient (when $f \geq 1$ crisis resolution has already been efficient in the absence of protection). However, the sovereign's payoff (and thus moral hazard) increases compared to the bondholder's optimal protection. This is because the joint payoffs for the sovereign and the bondholder have increased (as crisis resolution becomes more*

[24] We have assumed that the bondholder can fully obtain the liquidation value of the project. If this were not the case, the renegotiation problem in the absence of protection would be more pronounced, making the effect of credit derivatives in terms of improving the bondholder's outside option even stronger. Note also that while reducing renegotiation is unambiguously beneficial in our model, there are also arguments for why this may be costly (see, for example, Weinschelbaum and Wynne, 2005).

efficient and recalling that the protection seller breaks even) but the bondholder's payoff has not increased (otherwise, the bondholder's optimal protection q^* from Proposition 2 would not maximize his payoffs). ■

Thus, there is a potential case for intervention. The reason why the bondholder does not choose protection which achieves optimal resolution is that when $k > f > k - c$ the payout the sovereign makes to the bondholder and the protection seller under default (k) is larger than the maximum attainable payout under restructuring (f).[25]

5 Informational Problems

An efficient resolution of crises is likely to be complicated in practice because a sovereign may have superior information about its repayment ability, that is the productivity of the project. The bondholder does not then know whether the sovereign will be able to deliver on the restructuring offer, which the sovereign may use to his advantage.

We assume now that there are two states of nature, high and low, occurring with positive probabilities π and $1 - \pi$, respectively. These states materialize at the time of the crisis in period 1. Output of the project in the high state is $f^H > k$, while in the low state output is $f^L < k - c$. An efficient crisis resolution would thus require restructuring in the high state and default in the low state. The sovereign's informational advantage arises because he is assumed to have full knowledge of the states in a crisis, while the bondholder only knows their prior probabilities.

Lemma 1 *Equilibrium crisis resolution cannot be conditional on the state of the project (no separating equilibria).*

Proof. *Suppose that there were a separating equilibrium, where without loss of generality the sovereign offers r^L in the low state and r^H in the high state with $r^L \neq r^H$. The*

[25] Proposition 3 also suggests that credit protection can overcome the inefficiencies which arise because the sovereign's default costs are private. Thus, credit derivatives may be a substitute for policies which aim at increasing the pledgeable income of sovereigns (e.g., Tirole, 2002, and Ghosal and Miller, 2003).

bondholder then learns about the state of the project from the offer, implying that there are no informational problems. It follows from Proposition 1 that in the low state there is default and the sovereign's payoff is $-c < 0$, while in the high state there is restructuring and the sovereign's payoff is at least zero. The sovereign could then strictly improve his payoff by offering r^H in the low state and thus achieve restructuring. Therefore, a separating equilibrium cannot exist. ■

Lemma 1 holds because in a separating equilibrium the sovereign always has an incentive to pretend to be in the high state. Therefore, there can only be pooling equilibria, in which the sovereign makes a restructuring offer which is independent of the state. Proposition 4 derives the equilibrium crisis resolution in the absence of protection, where for convenience we define with $\widetilde{f} := \pi f^H + (1-\pi) f^L$ the (prior) expected value of output and with $\widetilde{\min}(r, f) := \pi \min(r, f^H) + (1-\pi)\min(r, f^L)$ the expected repayment on a restructuring offer r.

Proposition 4 *In the absence of protection there is restructuring with r such that $\widetilde{\min}(r, f) = k$ whenever $\widetilde{f} \geq k$ and default otherwise.*

Proof. *Analogous to Proposition 1: the sovereign still always prefers restructuring, while the bondholder needs a repayment fulfilling $\widetilde{\min}(r, f) = k$ to accept. For $\widetilde{f} \geq k$ a restructuring offer that guarantees such a repayment is feasible as then for $r = f^H$ we have that $\widetilde{\min}(f^H, f) = \widetilde{f} \geq k$, while for $\widetilde{f} < k$ it is not.* ■

Note that there are now two types of inefficiencies in the crisis resolution. First, there are only pooling equilibria, while an efficient outcome requires conditional crisis resolution (i.e., restructuring in the high state and default in the low state). Second, the equilibrium crisis resolution is inefficient even within the class of pooling equilibria. This inefficiency is similar to the one obtained when informational problems are absent: when $k > \widetilde{f} > k - c$ there is default (since $\widetilde{f} < k$) although the joint expected payoff under restructuring is higher (since $\widetilde{f} > k - c$).

The next proposition shows that the impact of credit protection is as in the absence of informational problems:

Proposition 5 *The introduction of protection does not change crisis resolution but reduces moral hazard; in particular there is restructuring with* $r = f^H$ *whenever* $\widetilde{f} \geq k$ *and default otherwise.*

Proof. *See Appendix 2.* ■

Similar to the previous section, the inefficient default equilibrium which arises for $k > \widetilde{f} > k - c$ can be avoided through a different choice of protection:

Proposition 6 *The bondholder's choice of protection is not always socially optimal in terms of crisis resolution. Crisis resolution can then be improved through appropriate short and long protection; however, this comes at the cost of increased moral hazard.*

Proof. *See Appendix 2.* ■

5.1 Costly Litigation

In the following we show that there is also a role for credit protection in overcoming the first inefficiency, that is to achieve conditionality in crisis resolution. This role arises when there are imperfections which make obtaining the liquidation value costly for the bondholder, for example because of legal fees.[26] To this end we assume that in order to force the government to pay out the liquidation value in a default, the bondholder would need to engage in litigation which incurs costs $l > 0$. Consequently, the bondholder finds it optimal to litigate only if $(1 - q)k \geq l$, that is if his share in the liquidation value (arising from the unprotected bonds) exceeds the litigation costs. We assume that in the absence of protection the bondholder would litigate, i.e., $k \geq l$. We also assume that litigation merely acts as a threat: whenever $(1 - q)k \geq l$ (i.e., the bondholder finds it optimal to litigate), the sovereign prefers to avoid being litigated by paying right away. However, when this condition is not fulfilled the sovereign can keep the liquidation value, as he knows that the bondholder will not litigate. We presume that the protection seller remains passive in that

[26] Such litigation costs have, for example, been emphasized in Haldane et. al. (2005). Interestingly, in our analysis, litigation costs can be welfare improving, as in their absence crisis resolution may not be conditional.

he does not litigate for his share in the liquidation value, which may be because his claim is not large enough to justify incurring the legal fees (at the end of this section we discuss the case for when the protection seller litigates).[27]

The next lemma shows that there are now situations in which credit protection can achieve conditional crisis resolution. The reason is that credit protection reduces the bondholder's benefits from litigation and thus may render the litigation threat not credible. As a consequence, the sovereign may keep the liquidation value in a default, which reduces his incentives to pretend to be in the high state in order to obtain restructuring.

Lemma 2 *When litigation is costly, credit protection may lead to conditional crisis resolution.*

Proof. *Consider short protection q that fulfills (i) $(1-q)k < l$ and (ii) $f^L \leq q \leq f^H - (k-c)$ and assume moreover (iii) $k - c > 0$ ((i)-(ii) are, for instance, fulfilled for $q = 1$ and $f^H \geq 1 + (k-c)$). From (i) we know that litigation is not credible. The sovereign can therefore keep the capital stock in a default, making his default payoff $k-c$. In order to obtain acceptance in a separating equilibrium the sovereign has to credibly offer $r = q$ as the bondholder's gross payoff under default is now only q (since he no longer obtains a share in the liquidation value). The sovereign's payoff from restructuring is hence $max(f^L - q, 0) = 0$ in the low state and $max(f^H - q, 0) = f^H - q \geq k - c$ in the high state (from (ii)). It follows that the sovereign prefers to default in the low state but to have restructuring in the high state.* ■

We show next that there are also situations in which the bondholder does indeed find it optimal to choose a level of protection which achieves conditionality.

Proposition 7 *The introduction of protection may lead to conditional crisis resolution in the presence of litigation costs.*

Proof. *See Appendix 2.* ■

[27] Note that while contractual features typically preclude the protection seller to get involved in the restructuring pre-default, after default he has under physical delivery in principal the same position as an original bondholder.

However, as the next proposition shows, there are also situations where the bondholder does not choose protection that leads to conditionality, even if this is feasible and also socially desirable in terms of crisis resolution. Intuitively, this is because conditional crisis resolution only arises for levels of protection that render the litigation threat uncredible. The resulting loss of the liquidation value for the bondholder may outweigh the additional payoffs the bondholder may achieve due to the improved crisis resolution. The bondholder's choice of protection is therefore not necessarily efficient, creating a role for intervention.

Proposition 8 *The bondholder may not choose a level of protection that leads to conditional crisis resolution even when this is socially desirable in terms of crisis resolution.*

Proof. *See Appendix 2.* ■

Throughout this section we have assumed that the protection seller does not litigate himself. This seems plausible as long as the degree of protection is not very high: the protection seller's incentives to litigate are then limited as he only receives the insured part of the bonds in a default. Nevertheless, for large levels of protection he may find it optimal to litigate. This may be particularly relevant for protection sellers that have low litigation costs, which presumably is the case for *vulture funds*. Such funds are specialized in litigation and may also be less concerned about reputational issues, such as adverse implications for the relationship with sovereign lenders.[28] However, while complicating the analysis, this does not change the role of protection in achieving conditionality. This is because regardless of whether or not the protection seller litigates, the sovereign can keep the bondholder's share in the liquidation value in a default when bondholder litigation becomes uncredible (i.e., for $(1-q)k < l$). Therefore, sovereign's incentives to seek restructuring are reduced compared to the situation without protection.

[28] Low litigation costs for protection sellers suggest another role for protection: when litigation costs are so high that the bondholder's litigation threat is not credible in the absence of protection ($k < l$), protection may be used to make the litigation threat credible by transferring litigation to a more effective party (the protection seller). Credit derivatives, viewed in this way, can be efficiency improving by allowing for the sharing of tasks between the bondholder (with a comparative advantage in investing in bonds) and the protection seller (with an advantage in litigation).

6 Discussion and Extensions

In this section we extend the analysis to situations in which there are no strategic investors (6.1), there is a higher number of possible output realizations (6.2), there is a coordination problem among bondholders (6.3), or there is a possible bailout by the IMF (6.4).

6.1 No Strategic Investors

A crucial assumption in our analysis so far is the presence of strategic investors who have an influence in the restructuring process. Such investors can be members of the creditor committee (or in the absence of a formal creditor committee, players who are likely to be involved in the consultation period that typically precedes a formal restructuring offer) or for example the lead bank that was underwriting the bond issuance. In the following we consider the case where there are no strategic investors.

We assume that, rather than having a single bondholder, there is a continuum of bondholders. These bondholders take the overall restructuring outcome and the price of protection as given. As before, we assume that the price of protection equals the expected payments the protection seller has to make to a bondholder, net of the value of the restructured bonds he may obtain. Hence, the protection seller on average breaks even and can thus be ignored in the welfare analysis.

Proposition 9 shows that in the absence of strategic investors, any distribution of protection among bondholders forms an equilibrium.

Proposition 9 *In the case of a continuum of non-strategic bondholders and no informational problems, each allocation of credit protection represents an equilibrium.*

Proof. *First consider the equilibrium in the absence of credit protection. Let* s_i *(*$0 < s_i < 1$*) denote bondholder* i*'s share in the total number of (identical) bonds. We assume that in order for a restructuring offer to be successful, the proportion of bonds for which bondholders accept the offer should be at least* h*, where* $0 < h < 1$*. We also assume that, if all other bondholders accept or reject, no individual bondholder has enough bonds*

to influence the crisis outcome, i.e. $s_i < 1-h$ *and* $s_i < h$ *for all* i*. This is consistent with the existence of a collective action clause that prevents individual bondholders from holding out in the hope of fully recovering their initial investment. For a restructuring offer* r*, bondholder* i *now accepts if* $s_i \cdot r \geq s_i \cdot k$ *or if* $r \geq k$*. The sovereign can only credibly promise* $r \geq k$ *if* $f \geq k$*. Hence, as in the case of one bondholder, there will be restructuring with* $r = k$ *when* $f \geq k$ *and default when* $f < k$*.*

Now consider the equilibrium with credit protection. First note that bondholders are indifferent between different levels of credit protection. This is because of three reasons. First, as before, they are risk-neutral and hence there is no value of buying protection per se. Secondly, the price they pay for credit protection equals the expected net payments they will receive from the protection seller. And thirdly, since each individual bondholder cannot change the restructuring outcome, bondholders cannot (individually) use protection strategically to improve their outside option in negotiations with the sovereign. Hence, a bondholder's expected payoff does not change with his level of credit protection, making bondholders (individually) indifferent between all levels of protection.

The sovereign's restructuring offer will then depend on the distribution of the bondholders' protection level. An offer is now only successful if the proportion of bonds for which bondholders accept is at least h*. This condition is satisfied if the sovereign can credibly promise* $r \geq q_h + (1-q_h)k$*, where* q_h *is the* $(100 \cdot h)^{th}$ *percentile of the distribution of chosen protection levels. Hence, there will be restructuring with* $r = q_h + (1-q_h)k$ *whenever* $f \geq q_h + (1-q_h)k$ *or if* $q_h \leq \frac{f-k}{1-k}$*, and default when* $q_h > \frac{f-k}{1-k}$*. Since bondholders are indifferent between different levels of protection, we have that any distribution of protection with* $q_h \in [0,1]$ *represents an equilibrium.* ■

Thus, whether credit protection is desirable is, per se, undetermined. In particular, there may be outcomes where bondholders "overprotect" (for example, if all bondholders choose a q_i such that their outside option, $q_i + (1-q_i)k$, becomes larger than f even when $f > k$).

However, as the next proposition shows, the equilibrium derived in Section 4 (Propo-

sition 2), that is the equilibrium that maximizes bondholders' payoffs, remains an equilibrium. Hence, if bondholders can coordinate in their choice of the equilibrium (that is, if we rule out equilibria that are pareto-dominated among bondholders), we will obtain the same equilibrium as in Proposition 2. In this case, as previously discussed, credit protection is unambiguously welfare improving since it enhances the sovereign's ex-ante incentives.

Proposition 10 *In the case of a continuum of non-strategic bondholders and no informational problems, the equilibrium derived in Proposition 2 above remains an equilibrium and still maximizes the payoff of bondholders. In this equilibrium, there is restructuring with $r = f$ whenever $f \geq k$ and default otherwise. Credit protection then works in the same way as in the case of strategic bondholders. In particular, it does not change crisis resolution but reduces moral hazard in crisis avoidance.*

Proof. *Suppose each bondholder buys protection $q = \frac{f-k}{1-k}$ when $f \geq k$ and buys no protection otherwise. In this case there will be restructuring with $r = q_h + (1 - q_h)k = f$ when $f \geq k$ and default otherwise. Hence, for each f the bondholders obtain the maximum available payoff (f when $f \geq k$ and k when $f < k$) and the introduction of protection again does not change crisis resolution but reduces moral hazard in crisis avoidance. This equilibrium is identical to the equilibrium with strategic investors derived in Proposition 2 above and summarized in Table 2. To see that this is still an equilibrium in the case of non-strategic bondholders, note that an individual bondholder has no incentive to buy more or less protection, as he does not have enough bonds to influence the crisis outcome and hence cannot change his payoffs.* ■

In Section 4 we have also shown that even though the availability of protection is beneficial, there is scope for government intervention as bondholders may not choose the socially desirable level of protection. As the next proposition shows, there is still a similar role for government intervention. However, while in Section 4 this role arose because crisis resolution could be improved by *forcing* higher levels of protection (which then no longer constituted an equilibrium), it now suffices to have bondholders *coordinating* on these higher levels (that is, the higher protection levels also constitute an equilibrium).

Proposition 11 *In the case of a continuum of non-strategic bondholders and no informational problems, the protection level that was derived to be optimal in terms of crisis resolution in the presence of strategic bondholders (Proposition 3) still constitutes an equilibrium and is still socially optimal in terms of crisis resolution. In this equilibrium, there is restructuring with $r = k$ whenever $f + c \geq k$ and default otherwise.*

Proof. *Suppose each bondholder buys long protection $q_{LP} = \frac{c}{1-f}$ and short protection $q_{LP} = -\frac{c}{1-f}$. As in Proposition 3, protection now effectively starts only in period 2. Compared to the case of no protection, the bondholders' payoff has only changed in that under restructuring he now obtains $q_{LP} + (1 - q_{LP})f = f + c$ when $r > f$. Hence, there will be restructuring with $r = k$ whenever $f + c \geq k$ and default otherwise, implying that crisis resolution is now efficient. This equilibrium is identical to the allocation with strategic investors derived in Proposition 3 above. To see that this is an equilibrium in the case of non-strategic bondholders, note that an individual bondholder has no incentive to buy more or less protection, as he does not have enough bonds to influence the crisis outcome and hence cannot change his payoffs.* ■

In the case of non-strategic investors, the ability to coordinate on "good" equilibria hence becomes paramount. If coordination can be achieved, credit protection will still be beneficial. If not, efficient crisis resolution can be undermined.

There is now an even greater role for public policy. Public policy can now avoid coordination on equilibria that are not preferred by bondholders (and hence are also undesirable for ex-ante incentives). For example, the IMF may publicly announce desirable levels of sovereign protection; or governments may issue bonds with the "right" level of protection attached to them. The IMF may also state that it intends to give preferential treatment for bondholders that have chosen a certain range of protection in the case of a default (we discuss the role for the IMF more explicitly in Section 6.4). Public policy can, moreover, implement equilibria that improve upon crisis resolution itself. Arguably, such equilibria are more difficult to obtain as they are not preferred by bondholders themselves.

We have in the foregoing assumed that there are neither any direct costs nor benefits

for an investor from buying protection. The only effect of protection arose through its potential impact on crisis resolution. Suppose now that an (individual) investor has net costs of δ from buying protection (independently of crisis resolution). These costs may be positive ($\delta > 0$) due to some deadweight loss from buying protection. For example, the deadweight loss may be interpreted as arising from transaction costs for the investors, or capital costs and administrative costs for the protection seller which cause the price of protection to rise above its fair price.[29] Arguably, the (net) costs may also be negative ($\delta < 0$). This is in the presence of some benefits from buying protection, arising for example due to bondholders' risk-aversion.

The introduction of such costs (or benefits) has profound implications for the equilibrium level of protection. Consider the case of $\delta > 0$. In this case, the only equilibrium is for bondholders not to hold any protection. To see this, suppose that there is a bondholder who plans to hold a positive level of protection. If he chooses instead not to do so, he will get less payouts in states where the protection would otherwise have been triggered, but he also does not have to pay the price of protection. Since the bondholder perceives no influence over the restructuring process and the price of protection, he will be strictly better of doing so due to the deadweight loss from buying protection. In the presence of net-benefits, we have the opposite outcome: since bondholders perceive no influence over the restructuring process, they only take into account their direct gains from protection and will hence choose to protect fully. Thus, we can have either "underprotection" or "overprotection", depending on the sign of bondholders' net-costs.

It may be argued that credit derivatives markets will mature further in the foreseeable future (once the current turmoil has abated). The costs of buying protection for investors may hence fall over the longer term, thus making it more likely that investors overall perceive net-benefits from protection. If this is indeed the case, we may eventually

[29] Note that the results of the baseline model are robust to the introduction of such costs. This is because in areas where there is restructuring, a bondholder makes a discrete positive gain from increasing protection because he then extracts more from the sovereign. For sufficiently small δ, these gains will always dominate the deadweight costs.

expect "overprotection" to occur. The experience in other mature derivatives markets, however, suggests that hedging ratios are typically small[30], indicating that the costs of buying protection remain sufficiently high.

6.2 Discipline through the Price of Protection

In our baseline model, the bondholder only refrains from buying excessive protection (that is, protection that causes inefficient defaults) because the price of protection jumps when it exceeds a certain threshold. The reason for why there is a jump is that there is a single output state and hence there is a critical level of protection below which there is always acceptance, and above rejection. It would be more realistic, however, to presume that there are many possible realizations of output. Then, when there is an increase in the level of protection, there are some more states of the world (that is, realizations of output) for which there is default. Protection then has to be triggered slightly more often. As a result, the price of protection will raise gradually as the level of protection increases, increasingly discouraging the bondholder from further purchases. Thus, the (admittedly) extreme jump in the price is not necessary to provide discipline for the bondholder in order to avoid inefficient defaults.[31]

It is also not necessary that the bondholder is aware that the fair price of protection changes as he increases his protection level. The reason is that the bondholder ultimately has to buy a large amount of protection if he wants to influence the restructuring outcome. He will typically be unable to buy at once such an amount of protection in the market at a reasonable price. In order to minimize the price impact of his trades he will hence be forced to spread his purchases over time. But then also the price of protection will

[30] For example, Faulkender (2005) finds that firms hedge only 6.5% of their (fixed rate) bond issuances (and zero percent of their bank loans) through interest rate swaps.

[31] Note that there generally can not be an equilibrium with rational agents where a bondholder "over-protects" (in the sense of causing inefficient defaults). This would either imply that the protection seller did not price protection correctly. Or, if he did price it correctly, the bondholder would be better off by not bying protection at all (as shown in the baseline model).

raise over time, reflecting the changed restructuring expectations in the market arising from his higher protection level. Thus, even if the bondholder is myopic in the sense that he is not anticipating the impact of his protection level on the fair price, discipline will still be provided. Alternatively, the bondholder may try to purchase in a single, privately negotiated, deal from a protection seller. But then the protection seller will raise his offer price when the bondholders wants to purchase a large amount of protection, again providing some discipline.

6.3 Coordination Problems in the Restructuring Process

For our baseline model we have presumed that there are no coordination problems among bondholders during the restructuring process (at the beginning of this section we have already discussed coordination problems in buying protection). Thus, the model can be best thought of as being applicable in situations where there are institutions (such as the presence of creditor committees, or restructuring through the Paris or London Club), or contractual provisions (such as the adoption of collective action clauses, CACs) that facilitate creditor coordination.[32] However, our main results continue to hold if there are coordination problems among creditors.

To see this, consider the baseline model of Section 3 but now assume that there are two bondholders who each hold one sovereign bond (that is, each bondholder's claim against the sovereign is 1). This gives rise to the well-known holdout problem: a bondholder may reject a restructuring offer in the hope of recovering a larger part of his claim, given that the other bondholder has accepted. Because of this incentive to holdout, restructuring offers that would otherwise have been successful may now fall through, adding another

[32]Especially the use of CACs, which are designed to effectively reduce coordination problems (e.g. Haldane et. al., 2005), has increased substantially in recent years and is now the standard in international sovereign bond markets. At the end of February 2006, the share of outstanding bonds including CACs was already 60 percent, up from 40 percent three years earlier. In fact, most of the outstanding bonds without CACs were issued before 2003 and since June 2005 only one country (Jamaica) issued an international sovereign bond without CACs (IMF, 2006, Gelpern and Gulati, forthcoming 2007).

bias towards default to the restructuring process.

More specifically, assume that when one of the bondholders holds out (while the other accepts the restructuring offer), he can recover an amount j of his claim, where we assume $k < j < \min(1, 2k)$. First, the bondholder who holds out can thus secure a larger recovery value ($k < j$) than the single bondholder in our baseline model because the other bondholder has accepted the restructuring offer and is therefore not competing for (part of) the total liquidation value (which now equals $2k$, given that the total claim now equals 2). Second, we assume that the bondholder cannot recover his full claim ($j < 1$). We believe this assumption to be realistic given that the bondholder that holds out is on his own and can for example not pool his recovery expenditures (e.g. litigation costs) with other bondholders (in which case j can be thought of as 1 minus the costs of recovery). He may also have a weak negotiating position, given that any peer pressure on the sovereign to limit the losses of international investors will be small, since the other bondholder has accepted the restructuring offer (in which case j represents the maximum that the bondholder can extract from the sovereign). Finally, the recovery value j cannot exceed the total liquidation value, $2k$.

Consider now a (credible) restructuring offer of r by the sovereign made (jointly) to each bondholder. Even though one bondholder accepts the offer, the other bondholder may decide not to accept and to holdout in order to obtain j. In order to avoid a default, the sovereign thus has to offer $r \geq j$ to the bondholders. Since the sovereign can at most credibly promise f, there will be default when $f < j$. Such a default causes inefficiencies when $f > 2k - c$, that is when the total payoff of all parties under a restructuring is higher than under a default.

An obvious concern is that the incidence of inefficient defaults increases when a bondholder holds protection. The reason is that a bondholder is then (partially) insured for the part of his claim that he cannot recover from the sovereign under default $(1 - j)$, but not when he accepts the restructuring offer. More specifically, a bondholder's payoff (gross of protection) under a level of (short) protection q in the case of holdout is $j + (1 - j)q$, while the payoff from accepting the restructuring offer is still r. Therefore, in order to

secure restructuring, a sovereign would need to offer $r = j + (1 - j)q$ to the bondholders. This amount is increasing in the level of protection and may exceed f. In that sense, the availability of credit protection seems to worsen the holdout problem.

But let us now consider the bondholders' incentives to buy protection. As long as the sovereign can still achieve restructuring (that is when $j + (1 - j)q < f$), the bondholder unambiguously improves his position by buying more protection. This is because then the restructuring offer has to increase, but protection, since never exercised, does not cost anything (note that it does not matter who buys the protection, since both bondholders benefit from higher payouts). As a result, higher payoffs are extracted from the sovereign as long as there is still restructuring.

Can it be that the bondholder buys an amount of protection that makes restructuring impossible, hence causing default? For a protection level q, his (gross) payoffs from holding out are $j+(1-j)q$. Protection then has to be exercised on the part of the claim that is not recovered $(1 - j)$ and the costs of protection are hence $(1 - j)q$. Thus, his net gains from buying protection that leads to default are j. These net gains are independent of q and in particular equal to the net gains when there is no protection. Hence, buying protection does not increase his incentives to cause default. Summing up, protection has the same effect as in the baseline model: it reduces ex-ante moral hazard by allowing bondholders to extract more from the sovereign but does not undermine the efficiency of crisis resolution.

6.4 IMF bailouts

Our analysis so far has ignored the potential role of the IMF. In practice, the IMF frequently bails out bondholders by providing loans to distressed countries. This affects the unfolding of a potential crisis itself (by avoiding it from the start), but, more importantly in our context, may also have an effect on the bondholder's incentives to purchase protection.

We next extend our baseline model to allow for IMF bailouts and study their implications. We consider three different types of IMF intervention, depending on the timing of the intervention. First, an IMF bailout could take place *prior* to any restructuring ne-

gotiations between the sovereign and the bondholder. More specifically, at the beginning of period 1, when faced with a shortage of funds, the sovereign approaches the IMF for support. The IMF provides support with probability $\rho < 1$ (we assume $\rho < 1$ because if the IMF always bails out bondholders there is obviously no role for protection). The support takes the form of a loan of size 1 to the sovereign, which the sovereign has to repay in period 2. Thus, in the case in which the sovereign obtains IMF support, it can pay out the bondholder in full and the crisis is averted. Any protection the bondholder may have purchased is then not triggered. However, with probability $1 - \rho$ there is no support from the IMF. The sovereign may then make a restructuring offer to the bondholder in order to avoid a default, and events unfold as in the baseline model.

Secondly, an IMF bailout could take place in case of a failed restructuring offer only. In this case, the IMF first allows the restructuring negotiations to take place and then with probability $\rho < 1$ provides the sovereign with a loan of size 1 (to be repaid in period 2) in case of a failed restructuring to avoid the termination of the country's project. Again, if the IMF intervenes, the sovereign can fully repay the bondholder and carry on with the project, while any protection the bondholder may have purchased is not exercised. But with probability $1 - \rho$ there is no IMF intervention and the sovereign defaults, as in the baseline model.

Finally, IMF intervention may not just be conditional on a failed restructuring but may further be confined to failed restructurings in countries with high productivity projects only. This is consistent with the argument that the IMF should only intervene in case of (temporary) liquidity crises and not in case of solvency crises. The high and low states of nature in section 5 above can be thought of as liquidity and solvency crises, respectively. Hence, we extend the asymmetric information model in section 5 by allowing for IMF bailouts. We assume that the IMF has the same (superior) information about the state of nature as the sovereign and that with probability $\rho < 1$ it bails out the sovereign in case of a failed restructuring and a high productivity of the country's project.

Proposition 12 below shows that although the introduction of possible IMF bailouts in our model reduces the effect of protection on moral hazard in all three cases, it does not

eliminate this effect. Hence, also in the presence of possible IMF bailouts, bondholders can use credit protection to extract higher payments from the sovereign, thereby reducing ex-ante moral hazard.

Proposition 12 *In the presence of IMF bailouts, credit protection still does not change crisis resolution. It also continues to reduce moral hazard in crisis avoidance but to a smaller extent than when IMF bailouts are absent.*

Proof. *See Appendix 2.* ■

These models of IMF bailouts assume that the IMF support is independent of the bondholder's level of protection. The analysis may potentially be different if the IMF pays out less when the bondholder is protected. The reason is that the bondholder's incentive to purchase protection is then reduced because it lowers the (implicit) subsidy he receives from the IMF: the bondholder still has to pay for protection but protection now provides less benefits since the IMF may reduce its level of support accordingly. However, given the nature of the credit derivatives markets, this is an unrealistic scenario for an IMF intervention. It would require the IMF (and the sovereign who ultimately repays bondholders) to know exactly how much protection a bondholder holds. Since credit protection can be bought in decentralized (and anonymous) over-the-counter markets, there is little room for the IMF or the sovereign to obtain this information (and the bondholder itself clearly has no incentive to come forward with the fact that he has bought protection).

7 Summary and Conclusions

This paper has analyzed the implications of credit derivatives for sovereign debt crises. We find that in most cases they reduce debtor moral hazard by allowing a bondholder to increase his outside option. Furthermore, credit derivatives do not reduce the efficiency of crisis resolution when protection is chosen strategically, as the bondholder internalizes potential inefficiencies through a higher price for protection. When the bondholder is not fully informed about the future repayment abilities of the sovereign, they may even

facilitate conditionality in crisis resolution.

However, there is a potential role for government policy. First, a bondholder's optimal strategic choice of protection is not always socially efficient. This is, in particular, because he does not internalize the country's private benefits from not having to go through a default. Interestingly, the role for policy arises in this case because the bondholder does not buy 'enough' protection, either in terms of the extent or in the duration of protection. As credit derivatives markets are decentralized, direct regulation is unlikely to be effective. However, sovereigns (or supranational organizations) may sponsor certain forms of protection (for example by subsidizing protection sellers). Alternatively, they may issue bonds with protection attached to them which is guaranteed by a third party.

Second, levels of protection may not be efficient when there are no bondholders that choose protection for strategic reasons. Then, equilibria may arise where the protection chosen by bondholders hinders efficient crisis resolution, as feared by some policy makers. However, there are also always equilibria in which there are no negative ex-post effects of credit derivatives. In the absence of strategic bondholders there is hence a strong role for sovereign countries and/or supranational organizations in facilitating coordination on socially desirable equilibria of credit protection.

Appendix 1: Welfare

The sovereign chooses to incur the costs a at date 1 (and thus to avoid the crisis altogether) iff

$$P_S^{NC} + b - a > P_S^C$$

where P_S^{NC} and P_S^C are the sovereign's payoffs (gross of b and a) in the absence of a crisis and in a crisis, respectively. Hence, for appropriately defined $a_{\min}$ and $a_{\max}$, there is a cut-off value $\overline{a} \in [a_{\min}, a_{\max}]$ such that for $a \in [a_{\min}, \overline{a})$ the sovereign incurs the costs, while for $a \in [\overline{a}, a_{\max}]$ he does not, where $\overline{a}$ is given by

$$\overline{a} := P_S^{NC} - P_S^C + b$$

Note that for any a the crisis is fully under the control of the sovereign. However, this could be easily modified by assuming an upper limit on the size of the costs a the sovereign can incur (for example, because of limited domestic tax capacity).

Denoting with D the amount of funds raised in period 0, we have that the bondholder's expected return has to be equal to D. This is because debt markets are competitive and because there is no discounting (note that the agreed repayment will generally differ from D since it also has to compensate the bondholder for expected losses in crises). This condition can be written as

$$\int_{a_{\min}}^{\overline{a}} P_B^{NC} \phi(a) da + \int_{\overline{a}}^{a_{\max}} P_B^C \phi(a) da = D$$

where P_B^{NC} and P_B^C denote the bondholder's payoffs when there is no crisis and when there is a crisis, respectively. It follows that

$$dP_B^{NC}/dP_B^C < 0$$

implying that a lower payoff for the bondholder in a crisis has to be compensated by a higher payoff when there is no crisis.

Define, furthermore, with $P^{NC} := P_B^{NC} + P_S^{NC}$ $(= f)$ and $P^C := P_B^C + P_S^C$ the joint payoffs for the sovereign and the bondholder. Since the bondholder breaks even on average

we can ignore him in the welfare analysis. Welfare, W, is hence solely characterized by the sovereign's expected utility, which consists of the sum of the joint payoffs plus net benefits $b-a$ when there is no crisis ($a<\overline{a}$) and the joint payoffs when there is a crisis ($a\geq\overline{a}$), minus the bondholder's required return D

$$W=\int_{a_{\min}}^{\overline{a}}(P^{NC}+b-a)\phi(a)da+\int_{\overline{a}}^{a_{\max}}P^{C}\phi(a)da-D$$

We show next that welfare in the economy is increasing in the joint payoff in a crisis P^C but decreasing in the sovereign's payoff in a crisis P_S^C. Totally differentiating $W(P^C,\overline{P}_S^C)$ with respect to to P^C (i.e., holding P_S^C constant) gives

$$\begin{aligned}\frac{dW(P^C,\overline{P}_S^C)}{dP^C} &= \frac{\partial W}{\partial P^C}+\frac{\partial W}{\partial\overline{a}}\frac{d\overline{a}}{dP^C}=\frac{\partial W}{\partial P^C}+\frac{\partial W}{\partial\overline{a}}\frac{\partial\overline{a}}{\partial P_S^{NC}}\frac{dP_S^{NC}}{dP^C}\\ &= \int_{\overline{a}}^{a_{\max}}\phi(a)da+(P_B^{NC}-P_B^C)\phi(\overline{a})\frac{\partial\overline{a}}{\partial P_S^{NC}}\frac{dP_S^{NC}}{dP^C}\end{aligned}$$

Since $dP_B^C/dP^C=1$ for $P_S^C=\overline{P}_S^C$ we have thus $dP_S^{NC}/dP^C=d(P^{NC}-P_B^{NC})/dP_B^C=-dP_B^{NC}/dP_B^C>0$. From $\partial\overline{a}/\partial P_S^{NC}=1$ and $P_B^{NC}-P_B^C\geq 0$ (i.e., in expectation, the bondholder's payoff when there is no crisis is at least as high as when there is a crisis), it follows that $dW(P^C,\overline{P}_S^C)/dP^C>0$.

Totally differentiating $W(\overline{P}^C,P_S^C)$ wrt. to P_S^C gives

$$\begin{aligned}\frac{dW(\overline{P}^C,P_S^C)}{dP_S^C} &= \frac{\partial W}{\partial P_S^C}+\frac{\partial W}{\partial\overline{a}}\frac{d\overline{a}}{dP_S^C}=\frac{\partial W}{\partial P_S^C}+\frac{\partial W}{\partial\overline{a}}\left(\frac{\partial\overline{a}}{\partial P_S^{NC}}\frac{dP_S^{NC}}{dP_S^C}+\frac{\partial\overline{a}}{\partial P_S^C}\right)\\ &= 0+(P_B^{NC}-P_B^C)\phi(\overline{a})\left(\frac{dP_S^{NC}}{dP_S^C}-1\right)<0\end{aligned}$$

where the inequality follows because of $dP_B^C/dP_S^C=-1$ for $P^C=\overline{P}^C$ we have $dP_S^{NC}/dP_S^C=d(P^{NC}-P_B^{NC})/d(-P_S^B)=dP_B^{NC}/dP_B^C<0$. Hence, welfare is increasing in P^C and decreasing in P_S^C.

Appendix 2: Proofs

Proof. Proof of Proposition 5] Note first that in the presence of protection there are only pooling equilibria (the proof of Lemma 1 can be readily applied by replacing reference to Proposition 1 with Proposition 2). Suppose that the bondholder buys an amount of

short protection q^* such that his payoff under default becomes $q^* + (1-q^*)k = \widetilde{f}$ (i.e., $q^* = (\widetilde{f}-k)/(1-k)$) when $\widetilde{f} \geq k$ and buys no protection ($q^* = 0$) otherwise. When $\widetilde{f} \geq k$ there is then acceptance with $r = f^H$ as this r makes the bondholder's expected payoff from acceptance just equal to his outside option: $\widetilde{\min}(r, f) = \widetilde{\min}(f^H, f) = \pi f^H + (1-\pi)f^L = \widetilde{f}$. The bondholder's net payoff is then $\widetilde{f}$ as protection is not exercised. When $\widetilde{f} < k$ there is rejection as $q = 0$ (from Proposition 4) and the bondholder's net payoff is k. Thus, in each case the bondholder obtains the maximum available payoff available in a pooling equilibrium: $\widetilde{f}$ when $\widetilde{f} \geq k$ and k when $\widetilde{f} < k$. q^* is therefore the bondholder's optimal protection. From the above we have then that equilibrium crisis resolution is unchanged. However, the sovereign's payoff when $\widetilde{f} \geq k$ is now only zero (for $\widetilde{f} < k$ it is still $-c$). Thus, when $\widetilde{f} > k$ moral hazard is lowered. ■

Proof. Proof of Proposition 6] Suppose that the bondholder holds long protection with $q_{LP} = c/[(1-\pi)(1-f^L)] > 0$ and short protection with $q_{SP} = -q_{LP}$. Since $q_{SP} = -q_{LP}$, the bondholder is not protected in period 1. The bondholder's payoff from default is thus k under default. A restructuring offer of $r = f^H$gives the bondholder a return of f^H in the high state and $\max(f^L, q_{LP} + (1-q_{LP})f^L) = q_{LP} + (1-q_{LP})f^L$ in the low state (as then $r > f^L$ and he can exercise his protection). Hence his expected return is $\pi f^H + (1-\pi)(q_{LP} + (1-q_{LP})f^L) = \widetilde{f} + c$. Analogous to Proposition 4 it follows that there is restructuring whenever $\widetilde{f} + c \geq k$ and default otherwise, implying that crisis resolution is improved whenever $k > \widetilde{f} \geq k - c$. However, the sovereign's payoff (and thus moral hazard) increases compared to the bondholder's optimal protection. This is because the joint payoffs of the sovereign and the bondholder have increased (as crisis resolution becomes more efficient) but the bondholder's payoff has not increased (otherwise, the bondholder's optimal protection would not maximize his payoffs). ■

Proof. Proof of Proposition 7] Assume (i) $k = l$, (ii) $f^L \leq f^H - (k-c)$ and (iii) $k - c > 0$. Note that (i) implies that litigation is credible for $q = 0$ but not for $q > 0$. Consider short protection with $q = f^H - (k-c)$, which is larger than zero by (ii). Hence the litigation threat is uncredible. The conditions (i)-(iii) from Lemma 2 are then fulfilled.

Therefore, we have a separating equilibrium with $r = q = f^H - (k - c)$ in the high state and default in the low state. The bondholder's net expected payoff is $\pi q = \pi(f^H - (k-c))$ as $q = f^H - (k - c)$ is the payout that the sovereign makes in the high state, while there is no payout in the low state (note that this is also the maximum expected payoff the bondholder can achieve in a separating equilibrium as he has to guarantee the sovereign at least $k - c$ in the high state in order not to make the sovereign default).

Pooling equilibria can only obtain for levels of protection which do not fulfill condition (i) or (ii) in Lemma 2. There are three cases to consider: a) $q > f^H - (k-c)$, b) $0 < q < f^L$ and c) $q = 0$. Under a) litigation is uncredible. In order to achieve restructuring in a pooling, the sovereign would have to promise an expected return of q to the bondholder, thus making the sovereign's payoff under restructuring $\min(f^H - q, 0) < k - c$ in the high state and $\min(f^L - q, 0) = 0$ in the low state. These payoffs are smaller than the payoff under rejection $k - c > 0$. Thus, the sovereign prefers rejection, making the bondholder's net payoff zero as then there is no payout at all. Under b) litigation is also uncredible. If there is rejection, the bondholder's payoff is still zero, while if there is (pooling) acceptance, the bondholder's net payoff is q. Hence the bondholder's payoff is at most f^L as $q < f^L$. Under c) litigation costs play no role and we can use Proposition 4 to obtain that the bondholder's net payoff is k. Hence, since $0 < f^L < k$, the bondholder would choose case c) ($q = 0$) in a pooling. As shown above, a bondholder can secure himself $\pi(f^H - (k-c))$ in a separating equilibrium. Thus, the bondholder chooses a separating equilibrium whenever $\pi(f^H - (k - c)) \geq k$, which can be fulfilled, for example, for sufficiently large f^H. ■

Proof. Proof of Proposition 8] Assume that conditions (i)-(iii) in the proof of Proposition 7 hold and that $\pi(f^H - (k - c)) < k$, i.e., the bondholder's net payoff in a separating equilibrium is less than in a pooling equilibrium (from Proposition 7). The bondholder hence chooses pooling. Assume furthermore that $\widetilde{f} < k$. Recalling that the bondholder chooses $q = 0$ under pooling, it follows from Proposition 4 that there is default under pooling; hence the joint net payoffs of the bondholder and the sovereign are $k - c$. By contrast, the joint payoff in a separating equilibrium is $\pi f^H + (1-\pi)(k-c)$, which is larger

than $k-c$ by $f^H > k$. Thus, although the bondholder chooses a pooling equilibrium, crisis resolution is more efficient in a separating equilibrium. ■

Proof. Proof of Proposition 12] **(1) IMF bailout prior to restructuring:** When there is a bailout, the bondholder's payoff (gross of protection) is 1, and hence independent of his protection level. When there is no bailout, the restructuring outcome (for a given level of protection) is precisely the same as in the baseline model. This implies, first, that the bondholder's payoff in this situation is the same as in the baseline model. Second, it also implies that the price of protection is a fraction $1-\rho$ of the price in the baseline model, since only with probability $1-\rho$ the sovereign ultimately has a lack of funds. It follows that both the benefits of protection and the costs of protection are reduced by a factor $1-\rho$, compared to the baseline model. Therefore, the bondholder faces the same optimization problem as in the baseline model and the restructuring outcome hence will not change. However, the bondholder can now only extract higher payments from the sovereign (through the use of protection) with probability $1-\rho$. Therefore, the impact of protection on the sovereign's payoffs is lower and moral hazard is less mitigated. **(2) IMF bailout in case of failed restructuring only:** When there is a bailout, the IMF lends 1 to the sovereign, the bondholder is fully repaid and the sovereign's payoff is $\max(f-1,0)$. Hence, the sovereign's expected payoff under default is $\rho\max(f-1,0)-(1-\rho)c$, while it is still $\max(f-r,0)$ under restructuring. The sovereign will still always prefer restructuring if $f < 1+\frac{1-\rho}{\rho}c$ (this condition obtains when he offers the maximum credible amount, $r=f$). First consider the case where this holds. Given that the bondholder's payoff under default is now $\rho+(1-\rho)k$, the sovereign needs to credibly promise a return of $\rho+(1-\rho)k$ to obtain restructuring. When $f \geq \rho+(1-\rho)k$, this is feasible and hence there is restructuring with $\rho+(1-\rho)k$. When $f < \rho+(1-\rho)k$, there is default. Since $\rho+(1-\rho)k > k$, there are more defaults than in the baseline model (see Proposition 2). Now suppose again that the bondholder buys protection q^* such that $\rho+(1-\rho)(q^*+(1-q^*)k) = f$ when $f \geq \rho+(1-\rho)k$ and buys no protection otherwise. When $f \geq \rho+(1-\rho)k$ there is thus acceptance with $r=f$, while for $f < \rho+(1-\rho)k$ there is default. Hence, as before, for

each f the bondholder obtains the maximum available payoff: f when $f \geq \rho+(1-\rho)k$ and $\rho+(1-\rho)k$ when $f < \rho+(1-\rho)k$. And again protection does not change crisis resolution. Since the sovereign's payoff when $f \geq \rho + (1-\rho)k$ is now zero (when $f < \rho + (1-\rho)k$ it is still $\rho \max(f-1,0) - (1-\rho)c$), protection again lowers moral hazard. However, while in the baseline model protection reduced the sovereign's payoff under restructuring from $f-k$ to 0, it now reduces the sovereign's payoff from $f-(\rho+(1-\rho)k)$ to 0. Hence, the decrease in the sovereign's payoff is smaller and moral hazard is thus reduced to a lesser extent. Next consider the case where $f > 1 + \frac{1-\rho}{\rho}c$. The sovereign's payoff under default is now $\rho(f-1) - (1-\rho)c > 0$. Given that the sovereign's payoff under default is now positive, the bondholder can no longer extract the maximum available payoff f from the sovereign. The reason is that for a restructuring offer $r = f$, the sovereign's payoff under restructuring is 0 and hence the sovereign will now prefer default. In order for the sovereign to prefer restructuring, its payoff under restructuring $\max(f-r,0)$ should exceed its payoff under default $\rho(f-1)-(1-\rho)c$ (>0). Hence, the bondholder's optimal level of protection should now be such that $f-r \geq \rho(f-1)-(1-\rho)c$, where $r = \rho+(1-\rho)(q^*+(1-q^*)k)$. This condition is satisfied for $r \leq (1-\rho)(f+c)+\rho$ $(< f)$. Thus, there will be restructuring with $r = (1-\rho)(f+c)+\rho < f$. Given that $f > 1+\frac{1-\rho}{\rho}c > \rho+(1-\rho)k$, there will always be restructuring, as in the baseline model for these values of f. Concluding, for $f > 1+\frac{1-\rho}{\rho}c$ protection does not change crisis resolution and again reduces moral hazard to a lesser extent than in the baseline model. In fact, the reduction of moral hazard is smaller than for other values of f, since the bondholder can no longer extract the maximum available payoff f. **(3) IMF bailout in case of failed restructuring with high productivity only:** In this case the IMF only bails out in case of a failed restructuring and a high productivity of the project. The prior probability of being in the high state and being bailed out is π. As under (2) above, the possibility of a bailout increases the bondholder's outside option and therefore increases the incidence of defaults. Protection does not alter crisis resolution and can still be used to extract a higher payment from the sovereign and thus reduce moral hazard, although to a lesser extent than in the baseline model.[33] ■

[33] To save space, we do not report formal proofs of this case. They are available upon request.

References

[1] Arping, S.: 2005, 'Credit Protection and Lending Relationships'. *mimeo, University of Amsterdam.*

[2] Bank for International Settlements (Basel Committee on Banking Supervision): November 2008, 'OTC derivatives market activity in the first half of 2008'.

[3] Bolton, P. and O. Jeanne: 2005, 'Structuring and Restructuring Sovereign Debt: The Role of Seniority'. *NBER working paper no. 11071.*

[4] Bulow, J. and K. Rogoff: 1989, 'Sovereign Debt: Is to Forgive to Forget?'. *American Economic Review* **79**, 43–50.

[5] Chiesa, G. : 2008, 'Optimal credit risk transfer, monitored finance, and banks'. *Journal of Financial Intermediation* **17**, 464-477.

[6] Cossin, D. and G. Jung: 2005, 'Do Major Financial Crises Provide Information on Sovereign Risk to the Rest of the World? A Look at Credit Default Swap Markets'. *mimeo, HEC Lausanne.*

[7] de Brun, J. and U. Della Mea: 2003, 'Una Aproximación de Mercado a la Reestructuración de la Deuda Soberana: Lecciones de la Experiencia Uruguaya'. *Revista de Economia* **10**, 97–142.

[8] Dooley, M.: 2000, 'Can Output Losses Following International Financial Crises Be Avoided?'. *NBER working paper no. 7531.*

[9] Duffee, G. R. and C. Zhou: 2001, 'Credit Derivatives in Banking: Useful Tools for Managing Risk?'. *Journal of Monetary Economics* **48**, 25–54.

[10] Eaton, J. and M. Gersovitz: 1981, 'Debt with Potential Repudiation: Theoretical and Empirical Analysis'. *Review of Economic Studies* **48**, 289–309.

[11] Eichengreen, B.: 2003, 'Restructuring Sovereign Debt'. *Journal of Economic Perspectives* **17**, 75–98.

[12] Faulkender, M.: 2005, 'Hedging or Market Timing? Selecting the Interest Rate Exposure of Corporate Debt'. *Journal of Finance* **60**, 931–962.

[13] Federal Reserve Bank of New York: 2005, 'An Overview of the Emerging Market Credit Derivatives Market'.

[14] Gai, P., S. Hayes, and H. S. Shin: 2004, 'Crisis Costs and Debtor Discipline: The Efficacy of Public Policy in Sovereign Debt Crises'. *Journal of International Economics* **62**, 245-262.

[15] Gelpern, A. and M. Gulati: forthcoming 2007, 'Public Symbol in Private Contract: A Case Study'. *Washington University Law Quarterly.*

[16] Ghosal, S. and M. Miller: 2003, 'Co-Ordination Failure, Moral Hazard and Sovereign Bankruptcy Procedures'. *The Economic Journal* **113**, 276–304.

[17] Haldane, A. G., A. Penalver, V. Saporta, and H. S. Shin: 2005, 'Analytics of Sovereign Debt Restructuring'. *Journal of International Economics* **65**, 315–333.

[18] International Association of Restructuring, Insolvency, and Bankruptcy Professionals (INSOL): 2006, 'Credit Derivatives in Restructurings; A Guidance Booklet'. available online at http://www.insol.org

[19] International Monetary Fund: 2006, 'Report of the Managing Director to the International Monetary and Financial Committee on the IMF's Policy Agenda'. April 2006.

[20] International Swaps and Derivatives Association: 2008, 'ISDA 2008 Operations Benchmarking Survey'.

[21] Jeanne, O.: 2001, 'Sovereign Debt Crises and the International Financial Architecture'. *mimeo, IMF.*

[22] Kiff, J., F.-L. Michaud, and J. Mitchell: 2003, 'An Analytical Review of Credit Risk Transfer Instruments'. *Banque de France FSR* pp. 106–131.

[23] Krueger, A.: 2002, 'New Approaches to Sovereign Debt Restructuring: An Update on our Thinking'. *Address before the Institute of International Economics (April 1, 2002).*

[24] Morrison, A. D.: 2005, 'Credit Derivatives, Disintermediation and Investment Decisions'. *Journal of Business* **78**, 621–648.

[25] Packer, F. and C. Suthiphongchai: 2003, 'Sovereign Credit Default Swaps'. *Bank for International Settlements Quarterly Review* pp. 79–88.

[26] Pan, J. and K. Singleton: 2005, 'Default and Recovery Implicit in the Term Structure of Sovereign CDS Spreads'. *mimeo, Stanford University.*

[27] Powell, A.. and L. Arozamena: 2003, 'Liquidity protection versus moral hazard: the role of the IMF'. *Journal of International Money and Finance* **22**, 1041-1063.

[28] Ranciere, R. G.: 2001, 'Credit Derivatives in Emerging Markets'. *IMF Policy Discussion Paper.*

[29] Shleifer, A.: 2003, 'Will the Sovereign Debt Market Survive?'. *American Economic Review* **93**, 85–90.

[30] Spiegel, M. M.: 2005, 'Solvency Runs, Sunspot Runs, and International Bailout'. *Journal of International Economics* **65**, 203–219.

[31] Tirole, J.: 2002, *Financial Crises, Liquidity, and the International Monetary System.* Princeton: Princeton University Press.

[32] Verdier, P.-H.: 2004, 'Credit Derivatives and the Sovereign Debt Restructuring Process'. *mimeo, Harvard Law School.*

[33] Weinschelbaum, F. and J. Wynne: 2005, 'Renegotiation, Collective Action Clauses and Sovereign Debt Markets'. *Journal of International Economics* **67**, 47–72.